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Training Program Guidelines for Deicing/Anti-Icing of Aircraft on Ground

RATIONALE

Revision A of this document provides updated information in conjunction with other applicable SAE documents and editorial changes. Appendix D (Application Guidelines) now includes latest aircraft models and engines running guidelines were incorporated.

FOREWORD

The purpose of this document is to provide guidelines for the training of Ground, Flight and Dispatch personnel concerning the proper deicing and anti-icing of aircraft on the ground.

Revision A of this document provides updated information in conjunction with other applicable SAE documents and editorial changes. Appendix D (Application Guidelines) now includes latest aircraft models and engines running guidelines were incorporated.

Exposure to weather conditions, on the ground, that are conducive to ice formation, can cause accumulation of frost, snow, slush, or ice on aircraft surfaces and components that can adversely affect aircraft performance, stability, and control and operation of mechanical devices such as control surfaces, sensors, flaps, and landing gear. If frozen deposits are present, other than those considered in the certification process, the airworthiness of the aircraft may be invalid and no attempt should be made to fly the aircraft until it has been restored to the clean configuration.

Regulations governing aircraft operations in icing conditions shall be followed. Paraphrased, these rules relate that NO ONE SHOULD DISPATCH OR TAKE OFF AN AIRCRAFT WITH FROZEN DEPOSITS ADHERING TO COMPONENTS OF THE AIRCRAFT THAT ARE CRITICAL TO SAFE FLIGHT. A critical component is one, which could adversely affect the mechanical or aerodynamic function of an aircraft.

COMPLIANCE WITH SPECIFIC RULES FOR AIRCRAFT DEICING/ANTI-ICING ON THE GROUND ISSUED BY REGULATORY AVIATION AUTHORITIES ARE THE RESPONSIBILITY OF THE USER.

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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/ARP5149A

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1. SCOPE

1.1 Field of Application

1.1.1 This document establishes the minimum criteria for effective training of air carrier and contractor personnel to deice/anti-ice aircraft to ensure the safe operation of aircraft during ground icing conditions. Appendix D specifies requirements for particular airplane models.

1.1.2 Agreements and Contracts

This information is recommended as a basis for maintenance and service support agreements.

1.1.3 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and processes and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.1.4 All guidelines referred to herein are applicable only in conjunction with the referenced SAE specifications. Specific requirements for airplane model type are included as examples in Appendix D. Due to aerodynamic and other concerns application of deicing/anti-icing fluids shall be carried out in compliance with engine and aircraft manufacturers' requirements.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS1424	Deicing/Anti-icing, Aircraft, Fluid, SAE Type I
AMS1428	Fluid, Aircraft Deicing/Anti-icing, Non-Newtonian (Pseudoplastic), SAE Types II, III and IV
ARP1971	Aircraft Deicing Vehicle - Self Propelled, Large and Small Capacity
ARP4737	Aircraft Deicing/Anti-icing Methods
ARP4806	Aerospace - Deicing/Anti-Icing Self Propelled Vehicle Functional Requirements
ARP4902	Design and Operation of Aircraft Deicing Facilities
AIR9968	Viscosity Test of Thickened Aircraft Deicing/Anti-Icing Fluids
AS5635	Message Boards (Deicing Facilities)

2.2 ISO Publications

Available from International Organization for Standardization, 1 rue de Varembe, Case Postale 56, CH-1211, Geneva 20, Switzerland, Tel: +41-22-749-01-11, www.iso.org.

ISO 11075 Aerospace – Aircraft de-icing/anti-icing Newtonian fluids, ISO type I

ISO 11076 Aerospace – Aircraft de-icing/anti-icing methods with fluids

ISO 11077 Aerospace – Self-propelled de-icing/anti-icing vehicles – Functional requirements

ISO 11078 Aerospace – Aircraft de-icing/anti-icing non-Newtonian fluids, ISO type II

3. MANAGEMENT PLAN

The operator will develop, coordinate with other affected parties, implement, and use a management plan to ensure proper execution of its approved deicing/anti-icing program. The operator's management plan will identify the manager responsible for the overall deicing/anti-icing program, each subordinate manager, and describes each manager's functions and responsibilities which are needed to properly manage the certificate holder's deicing/anti-icing program. A plan encompassing the elements discussed in the following paragraphs is acceptable:

3.1 Flight Operations Plan

Determine the management position responsible for ensuring that all the elements of the management plan and the deicing/anti-icing program have been developed, properly integrated, and coordinated; that the plan and program have been disseminated to all those persons who have duties, responsibilities, and functions to perform in accordance with them; and that adequate management oversight of the program continues to be maintained. The following should be considered:

3.1.1 At each airport where operations are expected to be conducted in conditions conducive to ground icing, determine who will be responsible for deciding when ground deicing/anti-icing operational procedures are to be implemented.

3.1.2 Specify the functions, duties, responsibilities, instructions, and procedures to be used by flight crewmembers, aircraft dispatchers or flight followers and management personnel for safely dispatching or releasing each type aircraft used in its operations while ground deicing/anti-icing operational procedures are in effect. A plan should include a detailed description of how the certificate holder determines that conditions at an airport are such that frost, ice, or snow may reasonably be expected to adhere to the aircraft, and when ground deicing/anti-icing operational procedures must be in effect.

3.1.3 Determine who will be responsible for coordinating the applicable portions of the management plan and the deicing/anti-icing program affecting dispatch of the aircraft with the appropriate air traffic control tower (ATCT) personnel and other appropriate airport authorities, including: (i) Determine who will be authorized to enter into agreements with the manager of the ATCT at each airport regarding air traffic control (ATC) procedures affecting dispatch during ground icing conditions, and with each airport's manager regarding where aircraft may conduct pretakeoff contamination checks; and (ii) Ensure that a detailed description of the deicing/anti-icing program is incorporated in the operator’s manuals for flight crewmembers, dispatchers or flight followers and management personnel to use in conducting operations under ground icing conditions.

3.2 Ground Operations Plan

Determine the management position responsible for ensuring that all the elements of the management plan and the deicing/anti-icing program have been developed, properly integrated, and coordinated; that the plan and program have been disseminated to all those persons who have duties, responsibilities, and functions to perform in accordance with them; and that adequate management oversight of the program continues to be maintained. The following should be considered:

3.2.1 Detail the functions, duties, responsibilities, instructions, and procedures to be used by its ground personnel, maintenance personnel, and management personnel for safely dispatching or releasing aircraft used in its operations while ground deicing/anti-icing operational procedures are in effect.

3.2.2 At each airport where deicing/anti-icing will take place, determine who will be responsible for deciding when ground deicing/anti-icing operational procedures are to be implemented.

3.2.3 Determine who is responsible for ensuring that enough trained and qualified personnel, as well as adequate facilities and equipment, are available at each airport where the operator will deice/anti-ice aircraft.

3.2.4 Determine who will be responsible for coordinating the applicable portions of the management plan and the deicing/anti-icing program with the appropriate air traffic control tower (ATCT) personnel and other appropriate airport authorities, including:
(i) Determine who will be authorized to enter into agreements with the manager of the ATCT at each airport regarding air traffic control (ATC) procedures related to deicing/anti-icing of aircraft, and with each airport's manager regarding aircraft primary and secondary deicing/anti-icing locations.

3.2.5 Ensure that a detailed description of the deicing/anti-icing program is incorporated in the operator’s manuals for ground operations personnel and management personnel to use in conducting operations under ground icing conditions.

4. TRAINING AND QUALIFICATION

Deicing/anti-icing procedures must be carried out exclusively by trained and qualified personnel.

Training success shall be proven by exam which shall cover all training subjects as laid down in this document. Pass mark shall be in accordance with ARP4737. Only persons passing the exam can be qualified.

4.1 Both initial and annual recurrent training for flight crews, dispatchers, and ground crews shall be conducted to ensure that all such crews obtain and retain a thorough knowledge of aircraft ground deicing/anti-icing policies and procedures, including new procedures and lessons learned.

4.2 Flight crew, dispatcher and ground crew training programs must include a detailed description of initial and annual recurrent ground training and qualification concerning the specific requirements of the program and the duties, responsibilities, and functions detailed in the program.

4.2.1 Flight crew, dispatcher and ground crew training programs should have a Quality Assurance Program to monitor and maintain a high level of competence.

4.2.2 An ongoing review plan is advisable to evaluate the effectiveness of the deicing/anti-icing training received.

4.2.3 The program should have a tracking system that ensures all required personnel have been satisfactorily trained. Records of personnel training and qualification (see Figure 1) shall be maintained for proof of qualification.

4.3 At a minimum, flight crews, dispatchers and ground crews must be trained and qualified on the following subjects. The following subjects are categorized as flight, dispatcher or ground training concerns (recommendations concerning the content of training are provided in the appendix):

4.3.1 Clean Aircraft Concept (effects of frost, ice, snow, and slush on aircraft surfaces): This discussion is intended to provide an understanding of the critical effect of the presence of frost, ice, or snow on flight surfaces and should include, but is not limited to, the following: (Flight, Dispatcher, Ground)

a. Loss of Lift.

b. Increased drag and weight.

c. Decreased control.

d. Tendency for rapid pitch-up and wing roll off during rotation. (Flight and Dispatcher only)

e. Stall occurs at lower-than-normal angle of attack. (Flight and Dispatcher only)

f. Buffet or stall occurs before activation of stall warning. (Flight and Dispatcher only)

g. Aircraft specific areas.

(i) Engine foreign object damage potential.

(ii) Ram air intakes.

(iii) Instrument pickup points.

(iv) Leading edge device (LED) aircraft (aircraft that have slats or leading edge flaps) and non-LED aircraft.

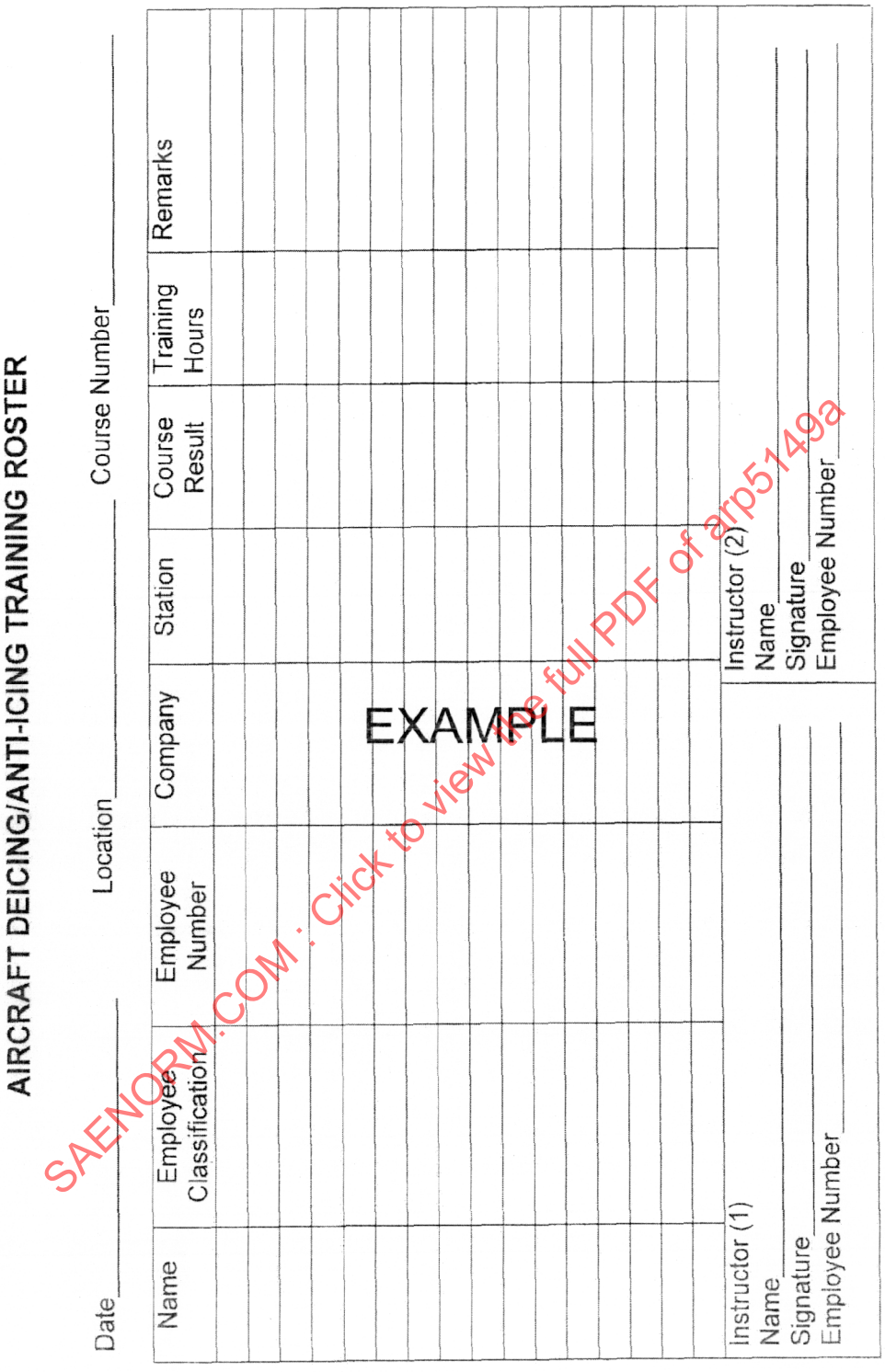


FIGURE 1 – AIRCRAFT DEICING/ANTI-ICING TRAINING ROSTER

4.3.2 Aircraft Ground Icing Conditions

Describe conditions that cause implementation of deicing/anti-icing procedures. (Flight, Dispatcher, Ground)

a. In-flight Ice Accumulation. Certificate holders should have procedures for flight crews of arriving flights to report occurrences of in-flight icing to the personnel responsible for executing the certificate holder's deicing/anti-icing program. In-flight ice accumulation could result in a ground deicing situation when flights are scheduled for short turnaround times; that is, for 30 minutes or less, and when ambient temperatures on the ground are at or below freezing.

b. Frost, including hoarfrost.

c. Freezing Precipitation. Snow, freezing rain, freezing drizzle, or hail which could adhere to aircraft surfaces.

d. Freezing Fog.

e. Rain or High Humidity on Cold Soaked Wing.

f. Rain or High Humidity on Cold Soaked Wing Fuel Tanks.

g. Underwing Frost. (may not require deicing/anti-icing within certain limits)

4.3.3 “Location Specific” Deicing/Anti-icing Procedures (Flight, Dispatcher, and/or Ground as appropriate)

Local differences concerning equipment, fluids used, fluid handling, deicing/anti-icing procedures, aircraft operated and communication procedures shall be incorporated and be pointed out on the particular station during the training.

4.3.4 Communications Procedures Between the Flight Crew, Ground Personnel, ATC, and Company Station Personnel

Proper communication procedures shall make sure that all required information concerning requests for deicing/anti-icing and various check results are communicated between the flight crew and the deicing/anti-icing personnel. Communications with ATC should include coordinating deicing/anti-icing of the aircraft with any proposed ATC push back time and coordinating any other special requirements needed for accomplishing required aircraft deicing/anti-icing checks. (Flight, Dispatcher, Ground)

4.3.5 Means for Obtaining Most Current Weather Information (Flight, Dispatcher, Ground)

4.3.6 Characteristics and Capabilities of Fluids Utilized (Flight, Dispatcher, Ground)

a. General fluid descriptions, composition and appearance.

b. Differences between Type I and Type II/III/IV deicing/anti-icing fluids.

c. Purpose and capabilities for each type of deicing/anti-icing fluids.

d. Deicing fluids

e. Anti-icing fluids

f. Approved deicing/anti-icing fluids for use (SAE, ISO, etc.)

g. Fluid specific information provided by fluid or aircraft manufacturer. (Flight, Dispatcher, and/or Ground as appropriate)

4.3.7 Fluid Storage and Handling (Ground)

a. Fluid storage

b. Fluid handling

c. Fluid sampling

d. Fluid testing

4.3.8 Deicing/Anti-icing Facilities and Equipment Operation Procedures (Ground)

This subject promotes an understanding of the capabilities of the deicing equipment and the qualifications for operation. The equipment portion of the training program should include the following:

a. Description of various equipment types.

b. Operation of the equipment.

Emergency procedures.

4.3.9 Health, Safety and First Aid (Flight, Dispatcher, Ground)

4.3.10 Environmental Considerations (Ground)

4.3.11 Fluid Selection (Flight, Dispatcher, Ground)

This subject describes the correct decision on which fluid mixture rate is appropriate for deicing/anti-icing under given conditions.

4.3.12 Contractor Deicing/Anti-icing (Flight, Dispatcher, Ground)

4.3.13 Methods/Procedures (Flight, Dispatcher, Ground)

a. Inspection of critical surfaces

b. Clear ice precautions

c. Flight crew/Ground crew preflight check requirement

d. Deice/Anti-ice determination

This subject describes the need for proper determination of which procedure is appropriate (one-step, two-step, preventive anti-icing) for deicing/anti-icing under consideration of given aircraft surface contamination, temperature and weather conditions and available fluids.

e. Deice/Anti-ice location

f. Communication prior to deicing/anti-icing

g. General deice/anti-ice precautions

h. Aircraft specific requirements

i. Deicing

(i) Requirements

(ii) Effective removal or frost, snow and ice (Ground only)

j. Anti-icing

(i) Requirements

(ii) Preventative anti-icing (Ground only)

(iii) Application (Ground only)

k. Deicing/Anti-icing

(i) One-step

(ii) Two-step

l. Guidelines for the Application of Deicing/Anti-icing Fluids

m. Post Deicing/Anti-icing Checks Requirement

n. Flight Control Check

o. Communications After Deicing/Anti-icing

4.3.14 The Use of Holdover Times (HOT) (Flight, Dispatcher, Ground)

a. Definition of HOT.

b. When HOT begins and ends.

c. Limitations and cautions associated with the use of HOTs.

d. Source of HOT data.

e. Relationship of HOT to particular fluid concentrations and for different types of fluids.

f. Precipitation category (for example, fog, drizzle, rain, or snow).

g. Precipitation intensity.

h. How to determine a specific HOT from the HOT range that accounts for "heavy", "medium" or "light" weather conditions. (Flight, Dispatcher)

i. Adjusting HOT for changing weather conditions. (Flight, Dispatcher)

NOTE: Ground Crews should receive some familiarization training on 4.3.14 (h) and (i).

4.3.15 Pretakeoff Check Requirement (Flight, Dispatcher)

a. Identification of representative surfaces.

4.3.16 Pretakeoff Contamination Check Requirement (where approved by regulatory authority) (Flight, Dispatcher, Ground)

a. Communications

4.3.17 Aircraft Surface Contamination Recognition (Flight, Dispatcher, Ground)

5. FLUID STORAGE AND HANDLING

5.1 Fluid Storage

Tanks should be dedicated to storage of the deicing and/or anti-icing fluid to avoid contamination with other fluids.

Storage tanks shall be constructed of materials compatible with the deicing/anti-icing fluid, as specified by the fluid manufacturer. If heated fluid is stored, care should be taken with plastic tanks, to ensure that they are suitable at the highest and lowest temperatures to which they will be exposed.

NOTE: If any ultraviolet transparent vessel is used, cover with an opaque material or an opaque coating, preferably light in color (Dark colors tend to generate higher temperatures inside the container when exposed to sunlight).

Tanks shall be conspicuously labeled to avoid contamination and to comply with applicable regulatory requirements.

Tanks shall be examined annually for corrosion and/or contamination. If corrosion or contamination is evident, tanks shall be repaired or replaced. To minimize corrosion at the liquid/vapor interface and in the vapor space, a high liquid level in the tanks is recommended.

NOTE: Although deicing/anti-icing fluids are generally non-corrosive, their vapor can be corrosive.

Storage temperature limits for the fluid shall comply with manufacturer's requirements.

Storage tanks should be located away from heat and exposed flames.

If a new tank is to be used, it should be appropriately cleaned and water washed before deicing/anti- icing fluid is introduced into it.

5.2 Fluid Handling

The performance characteristics of deicing/anti-icing fluids may be degraded by factors such as excessive mechanical shearing, chemical contamination, or overheating. Therefore, only compatible pumps, control valves, piping and application devices shall be used.

Fluid handling systems should be tested periodically or when modified to confirm that fluid meets manufacturer’s use specifications in accordance with 5.4.

5.2.1 Fluid Transfer Systems

The design of fluid transfer systems shall be in accordance with the fluid manufacturer’s recommendations.

Fluid transfer systems shall be dedicated to the specific fluid being handled to prevent inadvertently mixing fluids of different types or manufacturers. Different hose or connection types and sizes should be used to differentiate between the two fluids. Confirm that hose connections are compatible with fluid carrier’s equipment: adapters may be required.

NOTE: Totes used in the shipment of deicing/anti-icing fluid may not be rated for pressure. In this case, do not pressurize tote to transfer product. A low shear pump or gravity should be used.

All fill ports and discharge points shall be conspicuously labeled to prevent contamination due to inadvertent product mixing.

5.2.2 Application Equipment

Application equipment shall be clean before being initially filled with deicing/anti-icing fluid in order to prevent fluid contamination.

Requirements for suitable equipment are described in ARP1971.

Special Considerations for SAE Type II, III, and IV deicing/anti-icing fluids:

The performance characteristics of SAE Type II, III and IV deicing/anti-icing fluids may be degraded by excessive mechanical shearing or chemical contamination. Therefore, only compatible pumps, control valves, piping, and application devices shall be used. The design of fluid transfer systems shall be in accordance with the fluid manufacturer's recommendations.

5.2.3 Heating

SAE Type II, III, or IV deicing/anti-icing fluids, if heated, shall be heated in a manner to preclude fluid degradation in storage or application. The integrity of the fluid following heating shall be checked periodically. Factors like heating rate and heating time cycles should be considered in determining frequency of fluid inspections. Refer to fluid manufacturer's recommendations.

When heating, the fluid must be circulated. Depending on tank configuration, a slow moving stirrer, e.g. paddle or impeller or a low shear pump is acceptable. With a low shear pump, tank outlet and inlet points should be placed at opposite ends of the tank to aid fluid circulation. Circulation through a heater should continue for a few minutes after the heater has been shut off, to protect fluid from overheating. When fluid is heated, manufacturers recommendations on maximum temperature for storage should be followed. Overheating may cause degradation of the fluid and loss of performance. If fluid is diluted for deicing, it should not be stored above 140 °F for more than 2 weeks.

5.3 Fluid Sampling from a Storage Tank

The following procedures will permit sampling without damage or contamination of fluids.

5.3.1 Equipment Required

a. Fluid sampling device

b. Clean sample bottles, preferably new. Bottles must be plastic, high-density polyethylene or polycarbonate, to prevent contamination and permit safe storage and shipment to other locations. The bottles must have a tightly sealed plastic or plastic lined lid. The bottles should be of suitable size to satisfy testing requirements. There must also be a means of labeling the bottles.

c. Container for spills and to purge fluid.

d. Shop towels

5.3.2 Using a Specialized Tank Sampling Device

a. Clean the sampling device thoroughly, inside and out, with tap water. If necessary, when visible dirt exists on the device, a mild detergent or abrasive may be used for further cleaning but all traces of detergent or cleaner must be completely rinsed from the device prior to use. Dry the device thoroughly after cleaning.

b. Make sure that the lid of the sampling device forms a tight seal, so that fluid does not enter before it reaches the desired sampling level in the storage tank.

c. Open a hatch at the top of the storage tank. Insert the device into the tank to the desired level with the lid closed. Holding the device at the desired sampling level, open the lid and allow the container to fill. Close the lid and withdraw the device. Ideally obtain a total of three samples: one each from near the bottom, middle, and top of the fluid in the tank. The bottom sample should be taken as close to the bottom of the tank as possible; but the top sample should be

taken at least 6 inches below the surface of the fluid. Fluid on the surface should not be sampled, as natural evaporation of water into the tank's headspace from a very thin boundary layer on the fluid surface could give false quality measurements. The middle sample should be at least 1 foot above the tank bottom and 1 foot below the surface. Close the hatch of the storage tank.

d. Pour the fluid sample into a sample bottle. Immediately seal the bottle to avoid evaporation, contamination, or spillage. Label the bottle in accordance with section 5.3.4.

e. Clean and dry the sampling device thoroughly.

5.3.3 Using a Tank Sampling Valve

NOTE: This method can only be used to sample the fluid level at the valve, it cannot be used as a representative tank sample.

a. If more than one valve is available on the storage tank, select a valve that is small enough to provide a reasonable and controllable flow of fluid when opened fully, but is not so small that the fluid squirts out in a spray stream due to head pressure.

b. Place a container under the sampling valve.

c. Open the sampling valve fully as quickly as possible.

NOTE: Opening the valve partially or trying to control the fluid flow by throttling the sampling valve may shear the fluid and invalidate subsequent tests.

d. Allow at least 10 liters (2.5 gallons) of fluid to flow into the container and purge the valve. Then insert the sample bottle into the flowing fluid to fill the bottle. Remove the bottle from the stream and shut off the valve.

e. Immediately seal the bottle to avoid evaporation, contamination, or spillage. Wipe bottle dry and label in accordance with 5.3.4.

5.3.4 Sample Labeling

(As a minimum, the following information should be written legibly and indelibly on each sample bottle immediately when filled)

a. Mixture dilution (e.g. 100/0, 75/25, 50/50)

b. Name of the person taking the sample,-company/station name and address.

c. Date the sample was taken.

d. Identification/location of the tank the sample was taken from.

e. Volume of fluid in the tank at time of sampling.

f. Where the sample was taken from: the top, middle, or bottom of the tank or from the sampling valve.

g. Brand name of the fluid and product type.

5.3.5 Care of Fluid Samples

To ensure accuracy and validity of tests, samples must be properly handled between the time they are collected and the time they are tested. Particular attention should be paid to manufacturer's recommendations. Fluids should:

a. Not be exposed to air. Keep bottles sealed.

b. Not be exposed to sunlight.

c. Not be exposed to temperature extremes, hot or cold.

d. Not be excessively agitated or sheared.

5.4 Fluid Testing

Fluid shall be checked routinely to assure that no degradation or contamination has taken place, e.g. at delivery and annually prior to the winter season.

5.4.1 Quality Assurance Checks

Delivery containers should be sealed to minimize the risk of tampering, and delivered with a certificate of analysis. In order to make sure the fluid has not been altered in transit, fluid quality checks should be made before transferring into storage. This process should be performed by trained personnel.

Consult fluid manufacturers for recommendations on quality assurance checks that should be made before transferring delivered fluid into storage. Below is an example of minimum checks that should be done.

Visual Check. Representative samples should be drawn from the delivery truck. The fluid's appearance should be translucent, with a proper color and an absence of any loose particles. If particles are found, some fluid should be flushed from the truck and another sample taken.

Refractive Index (freeze point) check. Consult fluid manufacturer for the proper refractive index (freeze point) readings and recommendations on suitable Refractometers for their fluid.

CAUTION: Care should be taken when dual scale (EG and PG) Refractometers are used to ensure that the proper scale reading is taken.

NOTE: If fluid sampled from the delivery does not meet the testing criteria, the fluid should be rejected. Do not load into storage facility. Immediately contact the manufacturer for disposition of the fluid.

Premixed fluid, as received from the manufacturer, should be checked by performing a visual check and refractive index (freeze point) check prior to initial service.

5.4.2 Periodic Testing

Fluid should be periodically checked to assure that properties have not been altered during storage or handling. Follow manufacturer’s recommendations.

Site-mixed fluid should have a refractive index (freeze point) check to ensure intended dilution. This check should be made prior to daily use, following system maintenance or after a fluid concentration change.

Check viscosity and pH at least annually. Contact fluid manufacturer for information regarding these checks.

5.4.3 Concentration Checks

Fluids of fluid/water mixture samples shall be taken from the deicing/anti-icing equipment nozzles on a daily basis when vehicles are in use. The sample shall be protected against precipitation.

NOTE 1: Equipment without a mixing system

Samples may be taken from the truck tank instead of the nozzle. Insure the fluid is at a uniform mix.

NOTE 2: Equipment with proportional mixing systems

Operational setting for the flow and pressure shall be used. Allow the selected fluid concentration to stabilize before taking sample.

NOTE 3: Equipment with automated fluid mixture monitoring system

The interval for refractive index checks has to be determined by the handling company in accordance with the system design.

5.5 Fluid Blending

Fluid blending systems are intended to provide increased storage capability and enable the use of deicing fluid at lower glycol concentrations. Depending on the blending system manufacturer, these systems may consist of the water supply, a refractometer, the glycol supply and the valve controls to regulate the deicing fluid concentration.

5.5.1 Fluid blending system operation requires detailed understanding of the relationship between the Outside Air Temperature (OAT), the freeze point buffer, the Lowest Operational Use Temperature (LOUT), the correct use of the HOT tables and the different types of fluid.

5.5.2 By the use of a refractometer, it shall be made sure that the concentration of the fluid provided by the fluid blending system meets the requirements set by the LOUT and the freeze point buffer.

5.5.3 Ensure that the water quality meets the requirements as published by the fluid blending system manufacturer.

5.5.4 Ensure that all fluid blending system valves are positioned properly for intended purpose.

5.5.5 Take the fluid level reading to confirm that the inventory levels are accurate at the completion of the fluid blending process.

6. DEICING/ANTI-ICING FACILITIES AND EQUIPMENT OPERATION PROCEDURES

6.1 Although there are many different manufacturers the basic function of the deicer remains the same.

6.2 The deicing equipment shall satisfy the general safety requirements, as appropriately, set down in the following SAE Aerospace Recommended Practices.

ARP1971 Aircraft Deicing Vehicle - Self-propelled, Large and Small Capacity

The information is also contained in:

ISO 11077 Aerospace – Self propelled Deicing/Anti-icing Vehicles – Functional Requirements

NOTE: See Appendix C for Training Manual Development.

6.3 As the use of specialized deicing facilities becomes more common, training should be provided in the use of facilities systems.

Specific areas may be, but are not limited to:

- fluid storage
- pumping and blending systems
- aircraft movement control systems
- aircraft and deicing equipment communication systems

7. HEALTH, SAFETY AND FIRST AID

Deicing/anti-icing fluid application may present health and safety issues to flight and ground personnel, as well as the passengers of the carrier. An effective training program should include the dangers, precautions and first aid associated with deicing/anti-icing fluid applications.

7.1 Health

7.1.1 Caution should be used when using deicing/anti-icing fluids. Consult the fluid manufacturer documentation (Material Safety Data Sheets) to determine hazards of the fluid in use and the appropriate precautions to take.

Application equipment presents additional hazards, such as heating and pressurization of fluids. Consult the equipment manufacturer to determine the hazards and the appropriate precautions to be taken.

7.1.2 Human Factors in Deicing Operations: Considerations should be given to factors such as, but not limited to, fatigue, lighting, labeling, special use fittings, memory aids and the effects of prolonged exposure to adverse weather. Special attention should be given to communications in order to avoid injury to personnel or damage to aircraft.

7.2 Safety

7.2.1 Aircraft may be damaged by indiscriminate application of deicing/anti-icing fluid or manual removal of contaminants. Areas on the aircraft that require special attention must be identified to the deicing/anti-icing crew during the initial/recurrent training.

7.2.2 A slippery condition may exist on the ground or equipment following deicing/anti-icing procedure. Caution should be exercised particularly under low humidity or non-precipitation weather conditions.

7.2.3 Training on safety equipment use should include (as applicable), but not be limited to:

a. Safety Belt or harness

b. Eye/face protection

c. Rain suits

d. Gloves

e. Hearing protection

f. Rubber boots

g. Any additional equipment identified by regulations or carrier.

7.3 First Aid

7.3.1 Specific procedures regarding emergency medical treatment should be developed.

8. ENVIRONMENTAL CONSIDERATIONS

It is important to understand that there is no simple answer to the question of what is required to achieve environmental compliance. Deicing/anti-icing operations may be restricted by regulatory agencies. The training program should reflect knowledge of the airport's/airline's environmental compliance obligations. The manner in which the deicing/anti-icing activities are carried out may determine whether or not the airline or airport meets its legal requirements.

8.1 Aircraft deicing personnel should be able to identify the primary chemicals that make up the deicing/anti-icing fluid they are using.

8.2 The environmental impact of the fluid should be understood by deicing/anti-icing personnel. Things to consider may include aquatic toxicity, biodegradability, biochemical oxygen demand, bacterial inhibition, etc.

8.3 The local person in the operation responsible for compliance with applicable regulations should understand the regulations that apply to deicing/anti-icing fluids or the specific chemicals being used. Some things that may be considered are data reporting requirements, monitoring requirements, storage requirements, and use restrictions.

8.4 Aircraft deicing/anti-icing personnel should be able to identify the local person in the operation responsible for compliance with applicable regulations.

8.5 Aircraft deicing/anti-icing personnel should know the airport's practices for collecting and disposing of spent aircraft deicing/anti-icing fluid, and should know how deicing/anti-icing operations need to be conducted to insure alignment with the airport's practices.

9. CONTRACT DEICING/ANTI-ICING

Many air carriers use other parties to perform their deicing/anti-icing operations. Training for contractor deicing/anti-icing services should include at least one of the following criteria:

9.1 Approved Training

An approved contract training program meeting the requirements of this document can be implemented. Flight crews must be advised of local differences.

9.1.1 Train the Trainer

If the contractor does not meet the requirements of this document a Train-the-trainer program can be utilized. The carrier trains the contract deicing/anti-icing personnel or designated trainer if the contractor must be trained to meet the carriers approved program.

9.2 Alternative Procedures

Alternative procedures at airports where contract service agreements are not present. For example, a trained and qualified flight crew member or other appropriately qualified certificate holder employee provides supervision and quality control during the deicing/anti-icing process and ensures contractor procedures meet the certificate holder's approved program standards.

10. METHODS/PROCEDURES

These procedures establish the recommended methods for deicing and anti-icing of aircraft on the ground to provide safe take off.

No aircraft will take off when frost, snow, slush, or ice is adhering to any critical surface.

10.1 Inspection of Critical Surfaces

Operators should identify for each type of aircraft used in their operations, the critical surfaces which should be checked on preflight, post deicing/anti-icing, and pretakeoff contamination checks. Information from the aircraft manufacturer should be used to determine the critical surfaces for each aircraft type. Examples of this information are available in appendix D. Contact the aircraft manufacturer for specific information.

The following is a general list of critical surfaces:

10.1.1 Wings, Tail and Control Surfaces

Shall be free of frost, snow, slush or ice. Some coating of frost may be permissible on wing tank lower surfaces cold-soaked by fuel. Ice can build up on aircraft surfaces during flight through dense clouds or precipitation. When ground OAT at the destination is low, it is possible for flaps and other moveable surfaces to be retracted and for accumulations of ice to remain undetected between stationary and moveable surfaces. It is, therefore, important that these areas are checked prior to departure and any frozen deposits removed.

10.1.2 Pitot Heads, Static Ports, Airstream Direction Detector Probes, and Angle of Attack Sensors

Clear of frost, snow, slush, ice, fluid residues, and protective covers.

10.1.3 Engine Inlets

Clear of internal ice and snow and fan shall be free to rotate. Under freezing fog, or other freezing precipitation conditions, it is necessary for the front and rear side on the fan blades to be checked for ice buildup prior to start-up. Any deposits discovered are to be removed by directing air from a low flow hot air source or other means recommended by the aircraft and engine manufacturer. Exceptions will be noted in the Engine Manufacturers Manual.

10.1.4 Air-Conditioning Inlets/Exits

Clear of frost, snow, slush or ice. Outflow valves clear and unobstructed.

10.1.5 Landing Gear and Landing Gear Doors

Unobstructed and clear of frost, snow, slush or ice.

10.1.6 Fuel Tank Vents

Clear of frost, snow, slush or ice.

10.1.7 Fuselage

Clear of ice and snow. In accordance with the aircraft manufacturers' manuals adhering frost may be allowed. Do not close any door until all ice or snow has been removed from the surrounding area.

10.2 Clear Ice Precautions

Clear ice can form on aircraft surfaces below a layer of snow or slush.

Significant deposits of clear ice can form in the vicinity of the fuel tanks, on wing upper surfaces as well as underwing. Aircraft are most vulnerable in regard to this type of buildup when one or more of the following conditions exist:

a. Wing temperatures remain well below 0 °C (32 °F) during the turnaround transit.

b. Ambient temperatures between -2 °C (8 °F) and +15 °C (59 °F) are experienced, although clear ice may form at other temperatures if conditions (a), (c) and (d) exist.

c. Precipitation occurs while the aircraft is on the ground.

d. When frost or ice is present on lower surface of either wing.

Clear ice formation is extremely difficult to detect. Therefore, when the above conditions prevail, or when there is otherwise any doubt that clear ice may have formed, a close examination shall be made prior to departure, in order to ensure that all adhering frozen deposits have in fact been removed.

NOTE: Low wing temperatures associated with this type of buildup normally occur when large quantities of cold fuel remain in wing tanks during the turnaround/transit and any subsequent refueling is insufficient to cause a significant increase in fuel temperature.

10.3 Flight Crew/Ground Crew Preflight Check Requirement

Prior to departure, conduct this check for adhering contamination on critical surfaces.

10.4 Deice/Anti-ice Determination

Deice aircraft if any frost, snow, slush or ice is adhering to any critical surfaces.

Anti-ice aircraft if there will be active frost or adhering contamination falling or blowing onto any applicable critical surfaces prior to take off.

10.4.1 Initiation of Deicing/Anti-icing

In the predeparture sequence, ground deicing/anti-icing may be initiated whenever the flight crew or ground personnel determine that deicing/anti-icing is required for safe dispatch. Typically this would be:

a. On overnight aircraft, prior to the flight crew's arrival.

b. Following a check by the flight crew and a request for deicing.

c. After a normal preflight inspection by ground personnel or the flight crew.

d. After the flight crew is on board the aircraft.

10.4.2 Deice/Anti-ice Location

Determine if deicing/anti-icing will be performed at the gate/terminal, off-gate or at a remote pad. When deicing/anti-icing is performed away from the gate make sure that the following items are accomplished prior to departing the gate:

a. All APU and engine inlet/exhaust areas are free of contamination prior to start,

b. All doors and door seals are free of contamination prior to closing,

c. Windows are clean and visibility is adequate from the flight deck, if aircraft will be taxied,

d. Tires do not appear to be frozen to the ramp,

e. Passengers are informed if applicable, and

f. Critical sensing devices are free of contamination.

10.5 Communication Prior to Deicing/Anti-icing

When the flight crew is onboard the aircraft the ground crew and flight crew will communicate:

a. Whether the aircraft needs to be deiced, anti-iced, or both including fluids to be used,

b. Engine running considerations

c. That the aircraft is configured and crews are ready for procedure to begin.

In a remote deicing/anti-icing operation, a positive communication link shall be maintained to the aircraft flight crew throughout the deicing/anti-icing process.

Communication to the flight crew may be verbal or by means of Electronic Message Boards. In the event of conflict, verbal communication shall take precedence.

10.6 General Deice/Anti-ice Precautions

10.6.1 The application of deicing/anti-icing fluid shall be in accordance with the requirements of the airframe/engine manufacturers, and local procedures.

10.6.2 With regard to HOT provided by the applied fluid, the objective is that it be equal to or greater than the estimated time from start of anti-icing to start of take off based on existing weather conditions.

10.6.3 Aircraft shall be treated symmetrically, that is, left hand and right hand side shall receive the same and complete treatment.

CAUTION: Aerodynamic problems could result if this requirement is not met.

10.6.4 Engines are normally shut down but may remain running at idle during deicing/anti-icing operations. Air conditioning and/or APU air must be selected OFF, or as recommended by the airframe and engine manufacturer.

10.6.4.1 Aircraft engines running

Engines are normally shut down but may remain running at idle during deicing/anti-icing operations. During deicing/anti-icing with aircraft engines running specific procedures and equipment must be employed e.g. to enable effective “front to rear” deicing of aircraft surfaces in accordance with safe operating practices. If these procedures and equipment are not employed refer to engines off procedures.

10.6.4.1.1 Propeller Aircraft

a. Use caution when removing contamination near the engine intake. Never spray deicing/anti-icing fluids directly into the engine intake.

b. Procedures shall be in place to ensure the equipment / the operator stays out of the danger area of the propeller.

c. Never expose parts of the deicing/anti-icing vehicle to the arc of the spinner.

d. For underwing deicing, the engine on the treated side must be OFF.

10.6.4.1.2 Jet Aircraft

a. Always stay out of the jet blast area with the deicing/anti-icing equipment.

b. Always stay out of the engine ingestion area with the deicing/anti-icing equipment. Danger areas can vary depending on the type of the aircraft.

c. Never spray deicing/anti-icing fluid into the engine intake.

10.6.4.1.2.1 Aircraft with wing-mounted engines

a. The deicing/anti-icing vehicle should always stay out of the jet blast during the deicing/anti-icing treatment.

b. The deicing/anti-icing vehicle should stay in front of the wing to avoid being exposed to the engine jet blast.

c. For deicing treatment of the landing gear, the deicing/anti-icing personnel should always stay in the nacelle until the engine on the side of the aircraft to be treated is turned OFF.

10.6.4.1.2.2 Aircraft with center-mounted engines

a. No additional restrictions for deicing/anti-icing the wings apply.

b. The deicing/anti-icing vehicle should always stay next to the center-mounted engine during deicing/anti-icing treatment of the empenage.

10.6.5 Do not spray deicing/anti-icing fluids directly onto brakes, wheels, exhausts, or thrust reversers.

10.6.6 Deicing/anti-icing fluid shall not be directed into the orifices of pitot heads, static vents, or directly onto airstream direction detectors probes/angle of attack sensors.

10.6.7 All reasonable precautions shall be taken to minimize fluid entry into engines, other intakes/outlets, and control surface cavities. Refer to Airframe/Engine Manufacturer specifications.

10.6.8 Do not direct fluid onto flight deck or cabin windows as this can cause cracking of acrylic or penetration of the window seals.

10.6.9 All doors and windows should be closed to prevent:

a. Floor areas being contaminated with slippery fluids

b. Upholstery becoming soiled

10.6.10 Any forward area from which fluid may blow back onto windscreens during taxi or subsequent take off shall be free of fluid prior to departure. If SAE Type II, III or IV fluids are used, all traces of the fluid on flight deck windows shall be removed prior to departure, particular attention being paid to windows fitted with wipers.

NOTE: Deicing/anti-icing fluid can be removed by rinsing with approved cleaner and a soft cloth or flushing with type I fluid.

10.6.11 Landing gear and wheel bays shall be kept free from buildup of slush, ice, or accumulations of blown snow. Refer to 10.7.1.3 (d) of this document.

10.6.12 When removing ice, snow, or slush from aircraft surfaces care shall be taken to prevent it entering and accumulating in auxiliary intakes or control surface hinge areas.

10.7 Deicing

Requirements: Adhering contamination shall be removed from aircraft surfaces prior to anti-icing or prior to take off.

Ice, slush, snow, or frost may be removed from aircraft surfaces by fluids or mechanical methods, alternate technologies or combinations thereof. Refer to airframe manufacturer's documentation for guidance. Any deicing process or method used shall ensure compliance with 10.11.

10.7.1 This section establishes the procedures for removal of the frozen precipitation with fluids.

10.7.1.1 General

For maximum deicing effect, heated fluids should be applied close to the surface of the aircraft skin to minimize heat loss. Fluid temperatures should not exceed aircraft manufacturer's recommendations.

NOTE: The heat in the fluid effectively melts any frost, as well as light deposits of slush, snow, and ice. Heavier accumulations require the heat to break the bond between the frozen deposits and the structure; the hydraulic force of the fluid spray is then used to flush off the residue. The deicing fluid will prevent re-freezing for a period of time depending on aircraft skin temperature, temperature of the fluid, OAT, fluid used, mixture strength, and the weather.

10.7.1.2 Ice, snow or frost dilutes the fluid. Apply enough hot deicing fluid to ensure that refreezing does not occur and all contaminated fluid is driven off.

10.7.1.3 For effective removal of snow and ice the following techniques should be adopted. Aircraft may require unique procedures to accommodate design differences.

a. Wings/Tail Plane: Spray from tip inboard to root from highest point of surface camber to lowest. However, it is possible that aircraft configuration and local conditions may dictate a different procedure.

b. Vertical Surfaces: Start at top and work down.

c. Fuselage: Spray along top centerline and then outboard. Ensure that it is clear of ice and snow in accordance with the aircraft manufacturer's manuals. Hoarfrost may be allowed in accordance with the aircraft manufacturer's manuals.

d. Landing Gear and Wheel Bays: Keep application of deicing fluid in this area to a minimum. Do not spray deicing fluid directly on wheels, on brakes or into wheel bays.

NOTE: It may be possible to mechanically remove accumulations such as blown snow, however, where deposits have bonded to surfaces they can be removed by the application of hot air, with the bristle end of a broom, or by spraying with hot deicing fluids.

e. Engines: Deposits of snow must be removed from engine intakes prior to departure. Any frozen deposits that may have bonded to either the lower surface of the intake or the fan blades may be removed by hot air or other means recommended by the engine manufacturer. If use of deicing fluid is permitted, do not spray directly into engine core.

10.7.1.4 For removal of Frost and Light Ice: A nozzle setting with a fan spray is recommended.

NOTE: Providing the hot fluid is applied close to the aircraft's skin, a minimal amount of fluid will be required to melt the deposit. (Refer to minimum distances required by aircraft manufacturers and fluid manufacturers).

10.7.1.5 For removal of Snow: A nozzle setting sufficient to flush off deposits and minimize foam production is recommended.

NOTE: Foam could be confused as snow.

NOTE: The method adopted will depend on the equipment available and the depth and the type of snow; i.e. dry and light or wet and heavy. In general, the heavier the deposits, the heavier the fluid flow that will be required to effectively and efficiently remove it from the aircraft surfaces. For light deposits of both wet and dry snow, adopt a similar procedure as for frost removal. Wet snow is more difficult to remove than dry snow and unless deposits are relatively light, selection of a high fluid flow will be found to be more effective.

NOTE: Under certain conditions it will be possible to use the heat, combined with the hydraulic pressure of the fluid spray to melt and subsequently flush off frozen deposits. However, where snow has bonded to the aircraft skin, the procedures detailed in 10.7.1.6 below should be utilized. Heavy accumulation of snow will always be difficult to remove from aircraft surfaces and vast quantities of fluid will invariably be consumed in the attempt. Under these conditions serious consideration should be given to manually removing the snow before attempting a normal deicing procedure.

10.7.1.6 For removal of Ice: Heated fluid shall be used to break the ice bond.

NOTE: The high thermal conductivity of metal skin is utilized when a jet of hot fluid is directed at close range onto one spot, until the bare metal is just exposed. This bare metal will then transmit the heat laterally in all directions raising the temperature above the freezing point (FP) and thereby breaking the adhesion of the frozen mass with the aircraft surface. By repeating this procedure a number of times the adhesion of a large area of frozen snow or glazed ice can be broken. The deposits can then be flushed off with either a low or high flow, depending on the amount of the deposit.

CAUTION: Consult aircraft manufacturers' limitations for maximum fluid application pressure and temperature.

10.7.2 Alternate Deicing Technologies

Alternate technology may be used to accomplish the deicing process. Refer to ARP4737 for information regarding any specific procedural recommendation associated with their use.

NOTE: Pre-step process to be done prior to deicing/anti-icing

A pre-step process to the deicing process, in order to remove large amounts of frozen contamination (e.g. snow, slush, or ice), may be considered to reduce the quantity of glycol-based deicing fluids that is needed.

This pre-step process may be performed with various means (e.g. brooms, forced air, heat, heated water, heated fluids with negative buffer freezing point). If the pre-step procedure is used, make sure that the subsequent deicing process removes all frozen contamination including the contamination that may have formed on surfaces and/or in cavities due to the pre-step process.

10.8 Anti-icing

Ice, slush, snow, or frost will, for a period of time, be prevented from adhering to or accumulating on aircraft surfaces by the application of anti-icing fluids. This section provides recommended procedures for the use of anti-icing fluids.

10.8.1 Required Usage

Anti-icing fluid shall be applied to aircraft critical surfaces when freezing rain, snow or other freezing precipitation may adhere to the aircraft prior to take off (per ARP 4737, Sec. 6.2).

10.8.2 Preventative Anti-icing

Anti-icing fluid may be applied to clean aircraft surfaces prior to the start of freezing precipitation. This will minimize the formation of adhering contamination prior to departure and often makes subsequent deicing/anti-icing easier or unnecessary.

10.8.3 General

For effective anti-icing an even film of fluid is required over the prescribed aircraft surfaces which are clean or which have been deiced. For longer anti-icing protection, undiluted SAE Type II, III, or IV fluid should be used. The high fluid pressures and flow rates normally associated with deicing are not required for this operation.

NOTE: SAE Type I fluids have limited effectiveness when used for anti-icing purposes. Little benefit is gained from the minimal HOT generated. The process should be continuous and as short as possible. Anti-icing should be carried out as near to the departure time as possible in order to utilize available HOT.

10.8.4 Anti-icing fluid Application Strategy

The anti-icing fluid should be distributed uniformly. In order to control the uniformity, all horizontal aircraft surfaces shall be visually checked during application of the fluid. The amount required will be visually indicated by the fluid just beginning to drip off the leading and trailing edges. Surfaces to be protected include:

a. Wing upper surface and leading edges

b. Horizontal stabilizer upper surfaces and leading edges and elevator upper surfaces

c. Vertical stabilizer and rudder

d. Fuselage upper surfaces (especially on aircraft with center-mounted engines), depending on amount and type of precipitation

CAUTION: It is possible that Anti-icing fluids may not flow evenly over wing leading edges, horizontal and vertical stabilizers. These surfaces should be checked to ensure that they are properly coated with fluid.

10.8.5 Under no circumstances shall an aircraft that has been anti-iced receive a further coating of anti-icing fluid directly on top of the contaminated film. Should it be necessary for an aircraft to be re-protected prior to the next flight, a complete deicing/anti-icing treatment shall be performed. Ensure that any fluid remaining from a previous treatment is flushed off before a further application of anti-icing fluid.

CAUTION: The repeated application of Type II, III or IV fluid may cause residues to collect in aerodynamically quiet areas, cavities and gaps. The application of hot water or heated Type I fluid in the first step of the deicing/anti-icing process may minimize the formation of residues.

Residues may rehydrate and freeze under certain temperature, high humidity and/or rain conditions and may block or impede critical flight control systems. These residues may require removal.

NOTE: When checking for residues, their visibility may be facilitated by misting with water.

10.8.6 Deicing/anti-icing near the beginning of the departure runway provides the minimum interval between deicing/anti-icing and take off.

10.9 Deicing/Anti-icing

If both deicing and anti-icing are required, the procedure may be performed in one or two steps. The selection of a one-step or two-step process depends upon weather conditions, available equipment, available fluids, and the HOT to be achieved.

NOTE: When longer HOTs are desired, use of undiluted SAE Type II, III, or IV fluid should be considered.

10.9.1 One-Step Deicing/Anti-Icing

This treatment is performed with an anti-icing fluid. Both 10.7 and 10.8 apply. The correct fluid concentration is chosen with regard to desired HOT, dictated by OAT and weather conditions. Refer to application guidelines in App. D of this document and holdover guidelines in section 11 of this document for guidance regarding fluid limitations.

CAUTION: Wing skin temperature may differ and in some cases may be lower than OAT. A stronger mix can be used under the latter conditions.

10.9.2 Two-Step Deicing/Anti-icing

The first-step deicing is followed by a second-step, anti-icing as a separate process. The first-step is performed with deicing fluid. The correct deicing fluid mixture is chosen with regard to OAT. The second-step is performed with anti-icing fluid. This fluid and its concentration are chosen with regard to desired HOT, which is dictated by OAT and weather conditions. The second-step shall be performed before first-step fluid freezes (typically within 3 min) if necessary area-by-area. Use a second-step spraying technique which replaces the first-step fluid and provide a sufficient amount of second-step fluid to completely cover the surfaces with an adequate fluid thickness. Where re-freezing occurs following the initial treatment, both first- and second-step must be repeated. Refer to application guidelines in App. D of this document for guidance regarding fluid limitations.

CAUTION: Wing skin temperature may differ and in some cases may be lower than OAT. A mix with higher glycol concentration can be used under these conditions.

CAUTION: In order to maximize HOT the second-step fluid must be applied to make sure there is minimum dilution and reaction with the first-step fluid.

Deicing/anti-icing near the beginning of the departure runway provides the minimum interval between deicing/anti-icing and take off.

10.10 Guidelines for the Application of Deicing/Anti-icing Fluids

Refer to Appendix D for application guidelines.

10.11 Post Deicing/Anti-icing Check Requirement

Conduct this check to ensure all critical surfaces are free of adhering contamination following deicing/anti-icing.

10.11.1 Flight Control Check

A flight control check should be considered according to aircraft type (see airframe manuals). This check should be performed after deicing/anti-icing.

10.12 Communications after Deicing/Anti-icing

Information about the deicing/anti-icing process shall be communicated to the flight crew when complete.

Communication to the flight crew may be verbal or by means of Electronic Message Boards or datalink. In the event of conflict, verbal communication shall take precedence.

10.12.1 Deicing/Anti-icing Report

This information shall then be communicated and recorded to the flight crew after fluid is applied by referring to the last step of the procedure.

a. Specify "Type I" for SAE Type I fluid, "Type II" for SAE Type II fluid, “Type III” for SAE Type III fluid and “Type IV” for SAE Type IV fluid.

   NOTE: If brand name fluid specific HOT charts are used (the fluid meets product on-wing viscosity requirements), report fluid brand name.

b. Specify the percentage of fluid within the fluid/water mixture (e.g. 100 = 100% fluid, 0% water and 75 = 75% fluid, 25% water).

   NOTE: Reporting percentage of fluid for SAE Type I fluids is not required and does not influence calculated HOTs.

c. Specify in local time the beginning of the final anti-icing step (e.g. 1330)

d. Optional Reporting Communications

(i) Specify date (day, written month, year) (e.g., 20 April 1990). (this is required for record keeping)

NOTE: Transmission of elements (a)-(c) to the flight crew confirms that a post deicing/anti-icing check was completed and the aircraft is clean.

Examples of the format to be used for flight crew information is as follows:

Type IV - 100% - 1400

Type I – 0942

10.12.2 Post deicing/anti-icing check and transmission of the Anti-icing Code to the Flight Crew

It shall be clearly defined by the aircraft operator which company is responsible for carrying out the post deicing/anti-icing check and providing the flight crew with the anti-icing code.

If two different companies are involved in the deicing/anti-icing treatment and post deicing/anti-icing check it must be ensured that the Anti-icing Code is not given before the post deicing/anti-icing check is completed.

The company carrying out the deicing/anti-icing treatment shall be responsible for the treatment and pass all information about the treatment to the company carrying out the post deicing/anti-icing check.

10.13 Prior to departure following deicing/anti-icing the flight crew should receive an “all clear” signal from the ground crew ensuring safe taxi clearances.

10.14 Station Deicing/Anti-icing Log

SEE FIGURE 2.

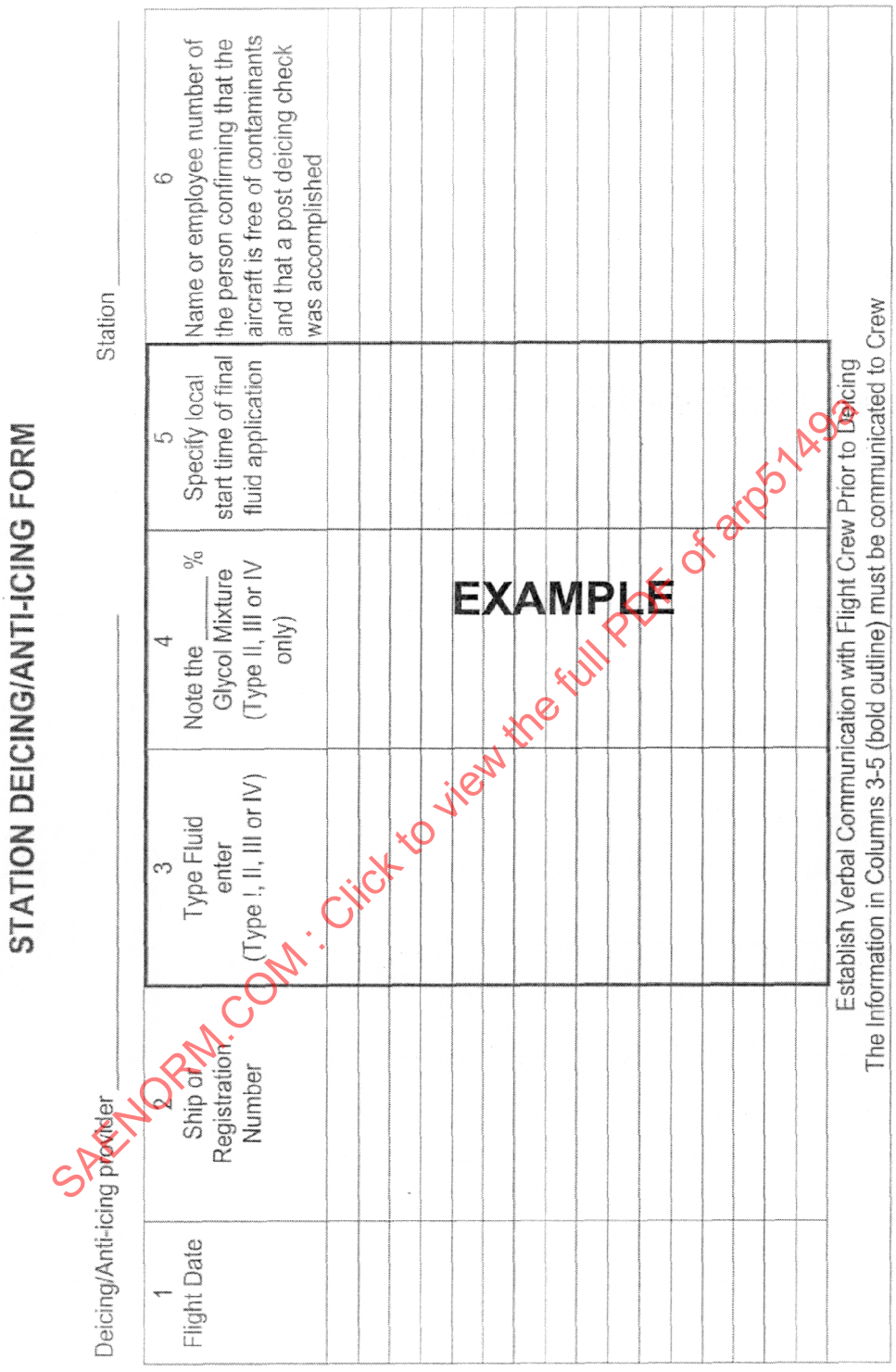


FIGURE 2 – STATION DEICING/ANTI-ICING FORM

11. HOLDOVER TIME (HOT)

Holdover time (HOT) is obtained by anti-icing fluids remaining on the aircraft surfaces. With a one-step deicing/ anti-icing operation, the HOT begins at the start of the operation and with a two-step operation at the start of the final (anti-icing) step. HOT will have effectively run out when frozen deposits start to form/accumulate on treated surfaces.

11.1 Type I Properties

Due to their properties, SAE Type I fluids form a thin liquid wetting film, which provides limited HOT, especially in conditions of freezing precipitation. With this type of fluid no additional HOT would be provided by increasing the concentration of the fluid in the fluid/water mix.

11.2 Type II, III, and IV Properties

SAE Type II, III, and IV fluids contain thickening agents which enables the fluids to form a thicker liquid wetting film on external aircraft surfaces. This film provides a longer HOT, especially in conditions of freezing precipitation. Undiluted thickened fluids generally provide the longest HOT protection.

11.3 Precipitation Chart Use

Type I, II, III and IV HOT guideline tables provide an indication of fluid protection time that could reasonably be expected under conditions of freezing precipitation. However, due to the many variables that can influence fluid performance, these times should not be considered as minimums or maximums as the actual time of protection may be extended or reduced, depending upon the particular conditions existing at the time. The lower limit of the published time span is used to indicate the estimated time of protection during moderate precipitation and the upper limit indicates the estimated time of protection during light precipitation.

CAUTION: The time of protection will be shortened in heavy weather conditions. High wind velocity and jet blast may cause a degradation of the fluid film. If these conditions occur, the time of protection may be shortened considerably. This is also the case when the fuel temperature is significantly lower than OAT. THEREFORE, THE INDICATED TIMES SHOULD BE USED ONLY IN CONJUNCTION WITH A PRETAKEOFF CHECK. THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

Once a HOT is established, weather conditions must be monitored. If conditions change, the HOT must be increased or decreased as appropriate.

HOT guidelines are for operational planning purposes only and are not a substitute for the pretakeoff check.

NOTE: Ongoing testing during winter season operations will allow HOT to be further defined.

11.4 For use of HOT Guidelines consult the fluid manufacturers technical literature for minimum viscosity limits of fluids as applied to aircraft surfaces.

11.5 Approved HOT Guidelines can also be obtained for individual fluid products and these HOTs will differ from the generic tables.

12. PRE-TAKEOFF CHECK REQUIREMENTS

Conduct this check when the aircraft has been anti-iced and the HOT has not expired. A pretakeoff check is performed by the flight crew periodically from the completion of anti-icing and just prior to take off.

This is a check normally conducted from inside the cockpit. Continually monitor weather and environmental conditions; adjust HOT if conditions change. Periodically inspect representative surfaces. If there is any doubt that the critical surfaces are free of adhering contamination perform a Pretakeoff Contamination Check or deice/anti-ice again.

12.1 Identification of Representative Surfaces

For each type of aircraft used in their operations, the certificate holders should list the representative surfaces which may be checked while conducting pretakeoff checks. Some aircraft manufacturers have identified certain aircraft surfaces which the flight crew can readily observe to determine whether or not ice, frost, slush, or snow is accumulating or forming on that surface and, by using it as a representative surface, can make a reasoned judgment regarding whether or not ice, frost, slush or snow is adhering to other aircraft surfaces. Certificate holder operational experience can also be used to define representative surfaces.

In the absence of this information, do not use the representative-surface method. The following guidelines should be considered in identifying a representative aircraft surface:

a. The surface can clearly be seen to determine whether or not ice, frost, slush or snow is forming or accumulating on the surface.

b. The surface should be an unheated surface.

c. Any portion of the wings visible from the flight deck should be considered.

d. Surfaces such as windshield wipers should also be considered.

12.1.1 The surface should be one of the first surfaces treated with deicing/anti-icing fluid during the deicing/anti-icing procedure; however, designation of representative surfaces is not limited to treated surfaces.

12.2 Pre-takeoff Contamination Check Requirement

Conduct this check when the aircraft has been anti-iced and the HOT has expired, or there is any doubt that the critical surfaces are free of adhering contamination prior to take off.

NOTE: Local regulatory requirements may vary. Refer to ARP4737 (“Checks”) and local requirements.

12.2.1 The pretakeoff contamination check must be completed within 5 minutes prior to the beginning the take off.

12.2.2 Operators must have appropriate pretakeoff contamination check procedures for flight crew members and other qualified ground personnel’s use to ensure that the aircraft’s critical surfaces (see 10.1) remain free of ice, frost, slush or snow when a HOT has been exceeded. Approved alternate procedures consisting of procedures, techniques, or equipment (such as wing icing sensors) may also be used to establish that the critical surfaces are free of adhering contamination.

CAUTION: Reliance on representative surfaces is not satisfactory for determining the aircraft is free of contamination while conducting this check. If any doubt exists concerning the aircraft’s condition after completing this check, the aircraft cannot take off unless it is deiced/anti-iced again and a new HOT is determined.

12.2.3 Operators of hard-wing aircraft with aft, fuselage-mounted, turbine-powered engines should conduct pretakeoff contamination checks from outside the aircraft, unless otherwise authorized in an approved program. The pretakeoff contamination check for these aircraft should include a tactile check of selected portions of the wing leading edges and the upper wing surfaces. Alternatives to a tactile check procedure may be approved.

12.2.4 Operators of other aircraft must conduct this check from outside the aircraft unless they can show that the check can be adequately accomplished from inside the aircraft, as specified in the certificate holder’s program. The program must detail procedures and requirements for conducting this check. Operators should consider the following in the development of guidelines for conducting pretakeoff contamination checks from inside the aircraft:

a. Can enough of the critical surfaces be seen to accurately determine whether or not they are free of contaminants? This determination should consider the aircraft type, the method of conducting the check (which is, from the cockpit or cabin), and other factors including aircraft lighting and other ambient conditions.

b. Does the certificate holder have procedures to recognize, and have flight crew members been properly trained on these procedures to recognize, changes in weather conditions so they will be able to determine if the critical aircraft surfaces could reasonably be expected to remain free of contamination?

12.2.5 Communications After Pre-takeoff Contamination Check

If the pre-takeoff contamination check is performed by qualified ground personnel, the flight crew must be informed whether or not the critical surfaces are free of adhering contamination. The flight crew must also be informed of the time the pre-takeoff contamination check was accomplished if the communication does not take place immediately following the check.

13. AIRCRAFT SURFACE CONTAMINATION RECOGNITION

Anti-icing fluid has lost its effectiveness when any wing surface changes from a smooth, clean, glossy surface to one on which frost, slush, snow, or ice can be seen as no longer being absorbed by the fluid. This includes random snow accumulation or a graying/dulling of the surface reflectivity caused by fluid deterioration. Loss of effectiveness may occur quickly with Type I fluid. Leading and trailing edges tend to fail first, as well as the downwind wing in a crosswind environment.

CAUTION: Under conditions of rain ~~(~~falling on cold aircraft surfaces~~)~~, freezing rain, or freezing drizzle, it is extremely difficult to determine whether a glossy wing surface is due to ice (especially clear ice), or the presence of Type I/II/III/IV fluid. If the flight crew is unable to determine if ice is present, request either a Pretakeoff Contamination Check (when available) or conduct another aircraft deicing/anti-icing treatment.

APPENDIX A - ABBREVIATIONS/DEFINITIONS

Abbreviations:

C = Celsius

F = Fahrenheit

H = Hours

HOT = Holdover Time

FP = Freezing Point

FPD = Freezing Point Depressant

min = Minutes

ATC = Air Traffic Control

ATCT = Air Traffic Control Tower

ISO = International Organization for Standardization

ICAO = International Civil Aviation Organization

OAT = Outside Air Temperature

Active Frost: Active frost is a condition when frost is forming. Active frost occurs when aircraft surface temperature is at or below 0 °C (32 °F) and at or below dew point.

Anti-icing is a procedure which provides protection against the formation of frost or ice and accumulation of snow or slush on clean surfaces of the aircraft for a limited period of time (holdover time).

Anti-icing Fluids are:

a. SAE Type I Fluid (see caution)

b. Mixtures of water and SAE Type I Fluid

c. Concentrates or mixtures of SAE Type II Fluid and water

d. Concentrates of SAE Type III Fluid

e. Concentrates or mixtures of SAE Type IV Fluid and water

CAUTION: SAE Type I fluids supplied as concentrates for dilution with water prior to use shall not be used undiluted, unless they meet aerodynamic performance and freezing point buffer requirement (Reference AMS1424).

NOTE: Temperature of both a. and b. shall be at least 60 °C (140 °F) at the nozzle. Upper temperature limit shall not exceed fluid and aircraft manufacturer's recommendations.

SAE Type II, III, and IV fluids for anti-icing are normally applied unheated on clean aircraft surfaces but may be applied heated. Application of cold (unheated) fluid for Type I for anti-icing is not allowed. A fluid temperature of 60 °C at the nozzles is mandatory to apply a (HOT) (Reference Table 1 and AMS1424).

Buffer - the difference between OAT and the freezing point of the fluid.

Checks: Examination of an item against a relevant standard by a trained and qualified person.

Clear Ice: A coating of ice, generally clear and smooth, but with some air pockets. It is formed on exposed objects at temperatures below or slightly above freezing temperature by the freezing of super cooled drizzle, droplets, or raindrops.

Cold Soaked Wing: The wings of aircraft are said to be cold “soaked” when they contain very cold fuel after flight at high altitude or after refueling with very cold fuel.

Critical Surfaces: A surface of an aircraft which shall be completely free of ice, snow, slush or frost before take off. Critical surfaces shall be determined by aircraft manufacturer.

Deicing is a procedure by which frost, ice, slush, or snow is removed from the aircraft in order to provide clean surfaces.

Deicing Fluids are:

a. Heated water

b. SAE Type I (see Caution)

c. Heated Concentrates or Mixtures of water and SAE Type I fluid

d. Heated Concentrates or Mixtures of water and SAE Type II fluid

e. Heated Concentrates or Mixtures of water and SAE Type III fluid

f. Heated Concentrates or Mixtures of water and SAE Type IV fluid

CAUTION: SAE Type I fluids supplied as concentrates for dilution with water prior to use shall not be used undiluted, unless they meet aerodynamic performance and freezing point buffer requirement (Reference AMS1424).

Deicing fluid is normally applied heated to assure maximum deicing efficiency.

Deicing/anti-icing is a combination of the two procedures described above. It can be performed in one or two steps.

Flight crew/Ground crew Preflight Check: Perform prior to departure. Note any adhering aircraft surface contamination and direct any required deicing/anti-icing operations. This check is normally conducted by flight crew during walk around preflight check.

Freezing Drizzle: Fairly uniform precipitation composed exclusively of fine drops [diameter less than 0.5 mm (0.02 in)] very close together which freezes upon impact with the ground or other exposed objects.

Freezing Fog: A suspension of numerous minute water droplets which freezes upon impact with ground or other exposed objects, generally reducing the horizontal visibility at the earth’s surface to less than 1 km (5/8 mile).

Freezing Point: Is the temperature at which e.g. a liquid solution changes from the liquid state to solid.

Frost: Ice crystals that form from ice saturated air at temperatures below 0 °C (32 °F) by direct sublimation on the ground or other exposed objects.

Hail: Precipitation in the form of small balls or pieces of ice with a diameter ranging from 5 to >50 mm (.2 to >2.0 in) falling either separately or agglomerated.

CAUTION: There is no HOT guideline for this condition.

High Humidity: An atmospheric condition where the relative humidity is close to saturation. HOT is the estimated time anti-icing fluid will prevent the formation of frozen contamination on the protected surfaces of an aircraft.

Hoarfrost: A deposit of interlocking ice crystals formed by direct sublimination on objects. Thin hoarfrost is a uniform white deposit of fine crystalline texture, which usually occurs on exposed surfaces on a cold and cloudless night, and which is thin enough to distinguish surface features underneath, such as paint lines, markings, or lettering.

Ice Crystals: A fall of unbranched ice crystals (snow crystals are branched) in the form of needles, columns, or plates.

CAUTION: There is no HOT guideline for this condition.

Ice Pellets: Precipitation of transparent (grains of ice) or translucent (small hail) pellets of ice, which are spherical or irregular and which have a diameter of 5 mm (0.2 in) or less. The pellets of ice usually bounce when hitting hard ground.

CAUTION: There is no HOT guideline for this condition.

Light Freezing Rain: Precipitation of liquid water particles which freeze upon impact with exposed objects, either in the form of drops, which, in contrast to drizzle, are widely separated. Measured intensity of liquid water particles are up to 2.5 mm or 25 grams/dm2/hour (0.10 in/h) with a maximum of 0.25 mm (0.01 in) in 6 minutes.

Newtonian Fluids: Fluids whose viscosities are shear independent and time independent. The shear rate of a Newtonian fluid is directly proportional to the shear stress. The fluid will begin to move immediately upon application of a stress; it has no yield stress to overcome before flow begins.

NOTE: SAE Type I fluids are considered Newtonian.

Non-Newtonian Fluids: Fluids whose viscosities are shear and time dependent and whose shear rate is not directly proportional to its shear stress. The fluid will not begin to move immediately upon application of a stress, it has a yield stress to overcome before flow begins.

NOTE: SAE Type II, III or IV fluids containing thickeners demonstrate a pseudoplastic behavior which is defined as a decrease in viscosity with an increase in shear rate.

Post Deicing/Anti-icing Check: Deicing/anti-icing procedures include a check to ensure all critical surfaces are free of adhering contamination performed by qualified ground personnel after the deicing/anti-icing fluid application has been completed. This check is an integral part of the aircraft deicing/anti-icing procedure. No aircraft shall take off after a deicing/anti-icing operation unless the aircraft has received a final check by a responsible authorized person.

Pretakeoff Check: A check of the representative or critical surfaces for adhering contamination performed by the flight crew prior to take off and within the HOT. This is a check normally conducted from inside the cockpit.

Pretakeoff Contamination Check: A check of the critical surfaces for adhering contamination. This check is accomplished after the HOT has been exceeded and must be completed within 5 minutes prior to beginning take off. The check must be accomplished from outside the aircraft, unless the certificate holder's program specifies otherwise (e.g. flight crew check from cabin). Certificate holder approved alternate procedures consisting of procedures, techniques, or equipment (such as wing icing sensors) may also be used to establish that the critical surfaces are free of adhering contamination.

Rain: Precipitation of liquid water particles, either in the form of drops of more than 0.5 mm in diameter or smaller drops which, in contrast to drizzle, are widely separated.

Rain or High Humidity (on Cold Soaked Wing): Water forming ice or frost on the wing surface, when the temperature of the aircraft wing surface is at or below 0 °C (32 °F).

Rime: A deposit of ice, produced by freezing of super cooled fog or cloud droplets on objects at temperatures below or slightly above freezing. It is composed of grains separated by air, sometimes adorned with crystalline branches.

Shear Force: Shear force is a force applied laterally on an anti-icing fluid. When applied to a Type II, Type III, or Type IV fluid the shear force will reduce the viscosity of the fluid; when the shear force is no longer applied, the anti-icing fluid should recover its viscosity. Shear forces are applied whenever the fluid is pumped, forced through an orifice (nozzle) or when subjected to airflow. If excessive shear force is applied, the thickener system could be permanently degraded and the anti-icing fluid viscosity may not recover and fluid performance can be effected.

Slush: Snow or ice that has been reduced to a soft watery mixture by rain, warm temperature and/or chemical treatment.

Snow: Precipitation of ice crystals, most of which are branched, star-shaped, or mixed with unbranched crystals. At temperatures higher than -5 °C (23 °F), the crystals are generally agglomerated into snowflakes.

APPENDIX B - COURSEWARE DEVELOPMENT GUIDE

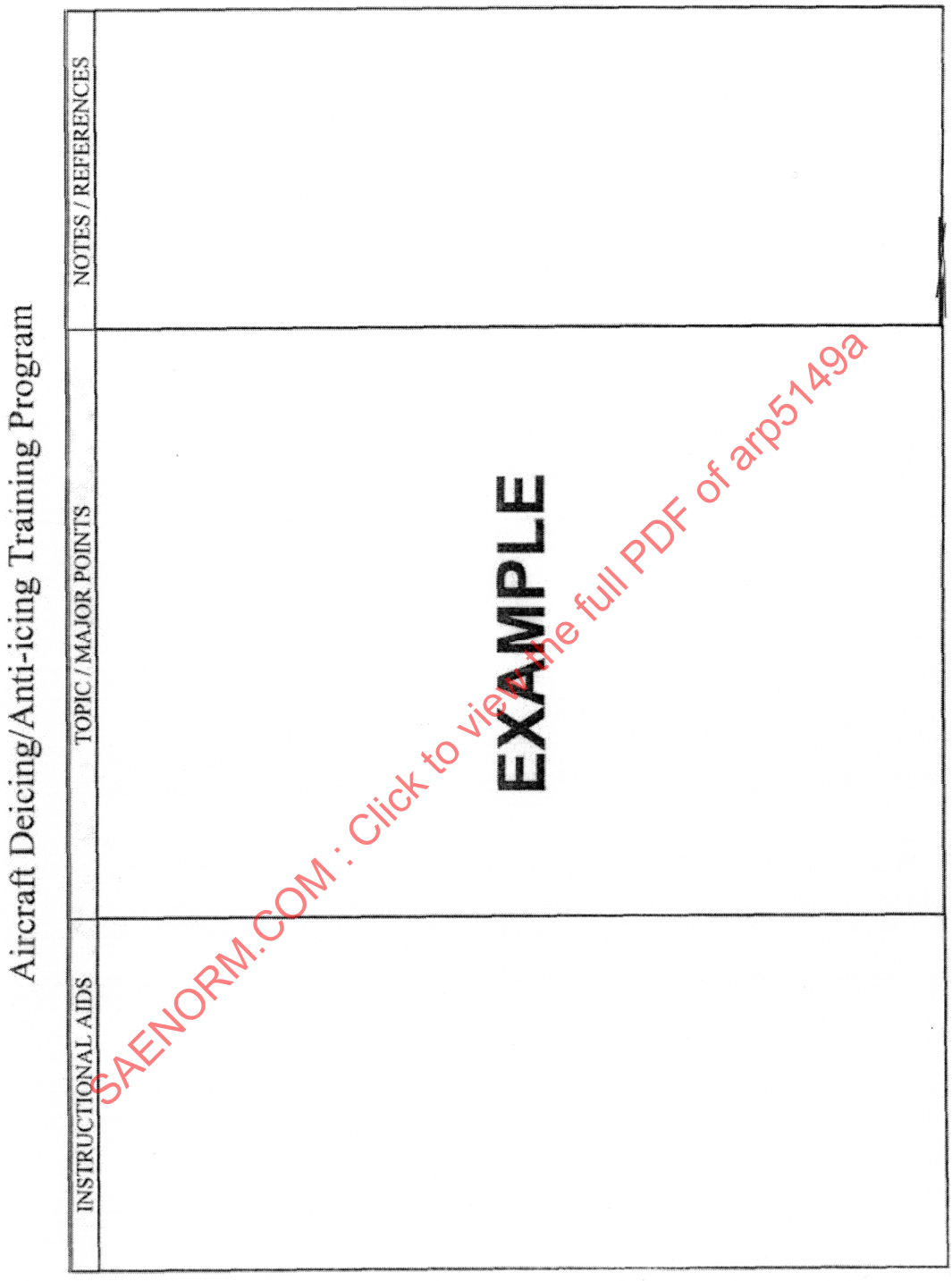


FIGURE B.1 – AIRCRAFT DEICING/ANTI-ICING TRAINING PROGRAM

APPENDIX C - DEICING/ANTI-ICING EQUIPMENT OPERATION PROCEDURES

C.1 DEICING/ANTI-ICING EQUIPMENT OPERATION PROCEDURES

These procedures cover the operation of deicing trucks in general. Although there are many different manufacturers the basic function of the deicer remains the same. The deicing equipment shall satisfy the general safety requirements, as appropriately, set down in the following SAE Aerospace Recommended Practices.

ARP1971 Aircraft Deicing Vehicle - Self-propelled, Large and Small Capacity

The information is also contained in ISO 11077 Aerospace – Self propelled Deicing/Anti-icing Vehicles – Functional Requirements.

C.2 PRIMARY FUNCTION

The primary function of the vehicle is to apply deicing/anti-icing fluid from variable heights to the surfaces of aircraft while driving around the perimeter. Warning: Do not drive a deicing vehicle above 4 mph (6 km/h) when boom is in the raised position.

NOTE: Manufacturer's operating specifications and Regulatory Requirements may be different than those shown here.

CAUTION: Combustion heaters and trucks should not be operated in confined or poorly ventilated areas to prevent asphyxiation.

CAUTION: The operator shall follow all recommended manufacturers operating procedures when using this type of equipment.

C.3 EQUIPMENT BASIC COMPONENTS

a. Boom and Basket Assembly

b. Deicing and Anti-icing Fluid Tanks

c. Heater System

d. Fire Extinguisher System

e. Auxiliary Engine or PTO

f. Emergency Shutdown System

g. Other Applicable Components

h. Communication Equipment

C.4 SAFETY EQUIPMENT

a. Safety belt or harness

b. Eye/face protection

c. Rain suits

d. Gloves

e. Hearing Protection

f. Rubber boots

C.5 BEFORE USE CHECKS

Before operating the deicer, a walk-around inspection must be performed. Operate and Check:

a. Engine(s)

b. Boom and Basket operation

c. Heater and pump operation

d. Nozzle and spray gun operation

NOTE: Perform a manufacturer recommended pre-operation users check before operating unit.

C.6 EMERGENCY PROCEDURES

C.6.1 Should a control valve fail or the need arises for a basket or the truck operator to halt boom movement, activate the EMERGENCY STOP SWITCH at the basket, the ground control station, or in the truck cab.

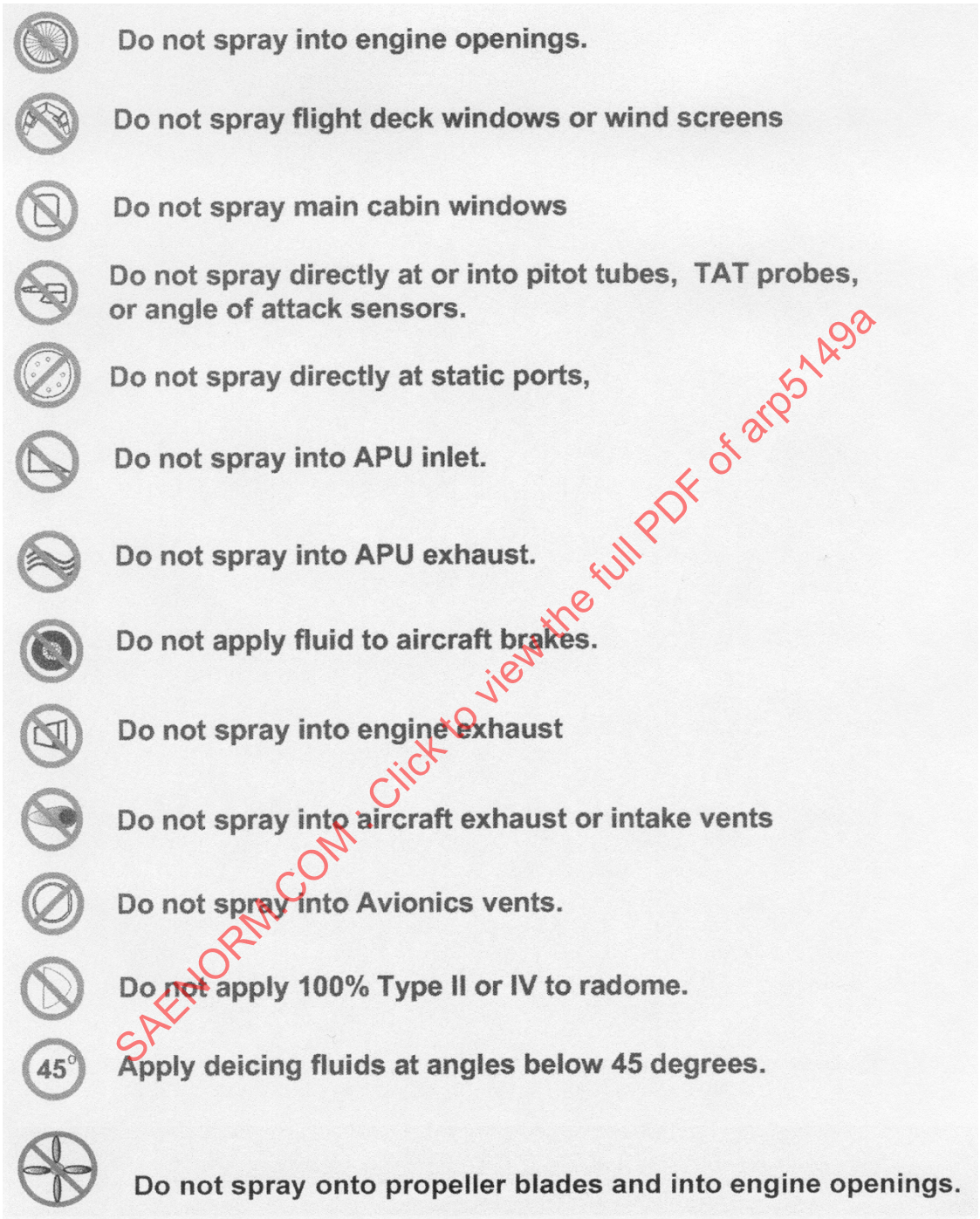
C.6.2 Should a fire start in the auxiliary engine compartment, an automatic fire extinguisher system will put out the fire and shut off the engine. Pulling a safety pin and striking a button can manually activate the system. Once this system has been used, maintenance will have to reset the system and determine the cause of the fire before the truck can be put back into service.

C.6.3 Should the auxiliary engine or the hydraulic pump fail, using the EMERGENCY HYDRAULIC PUMP while operating the hydraulic controls can move the booms. Check manufacturer's specifications for locations.

C.6.4 Should the basket operator become disabled, the booms can be operated from the lower control station.

C.6.5 In the event of an aircraft emergency, the flight crew will contact the deicing/anti-icing ground crew and will flash the aircraft landing, taxi, or turn lights ON and OFF to immediately alert the deicing/anti-icing ground crew. The deicing/anti-icing ground crew shall pull away from the aircraft and shall remain in visual contact with the flight deck.

APPENDIX D - APPLICATION GUIDELINES CONFIGURATION, CRITICAL COMPONENT, AND SPRAY AREA DIAGRAMS FOR AIRCRAFT LEGEND FOR DIAGRAM SYSMBOLS



Thin hoar frost is acceptable on the upper surface of the fuselage provided all vents and ports are clear. Thin hoar frost is thin enough to distinguish paint lines, marking or lettering.

Coating of frost up to 1/8 inch in thickness on the lower wing surfaces caused by very cold fuel in the area of the wing tanks between the front and rear spar is permissible.

Engine intake must be free of all contaminants, engine fan blades must move freely.

Engine intake must be free of all contaminants, engine fan blades must move freely. Fuselage must be inspected prior to engine start when conditions warrant.

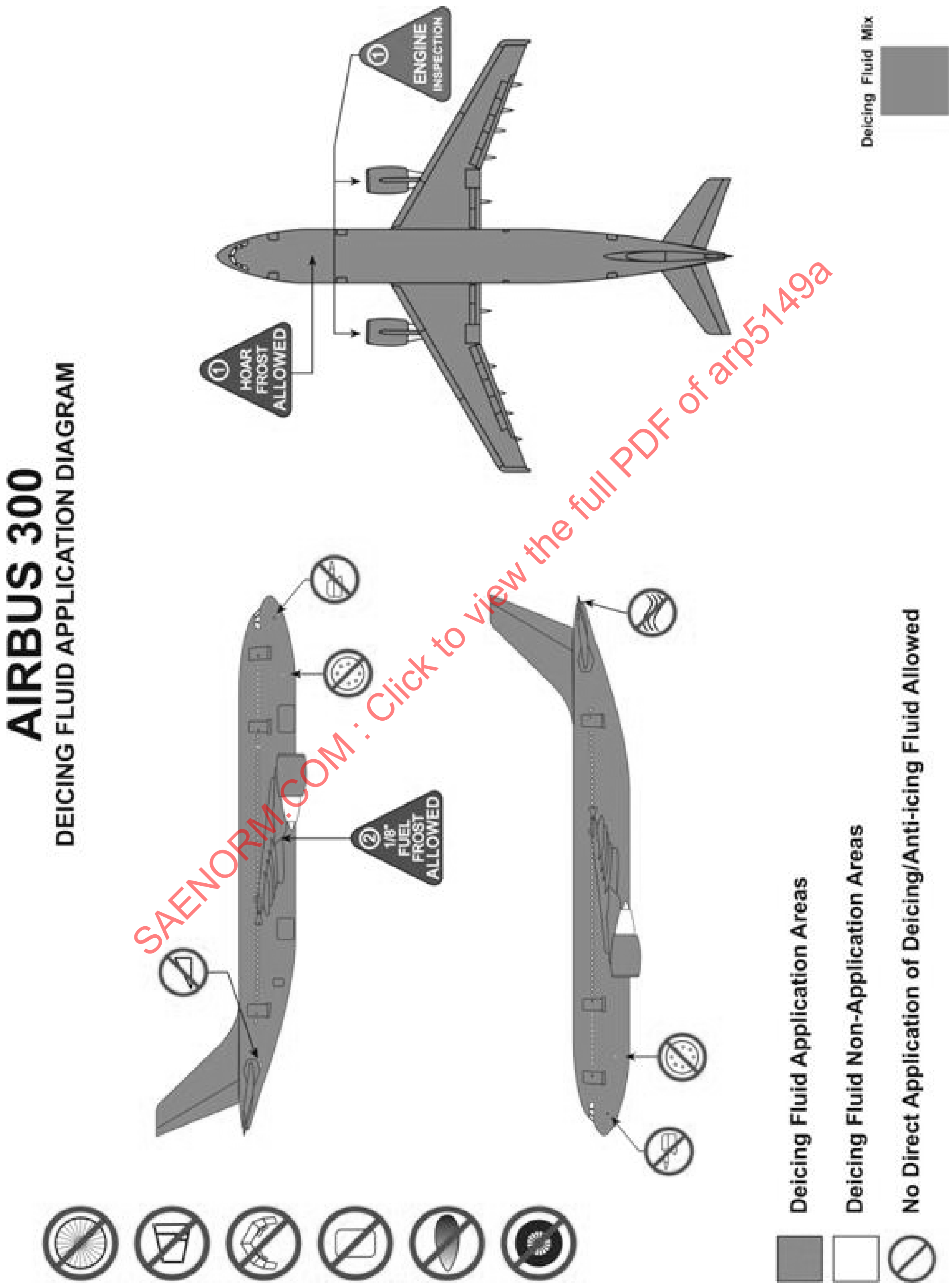
Propellers must be free of all contaminants before engine start.

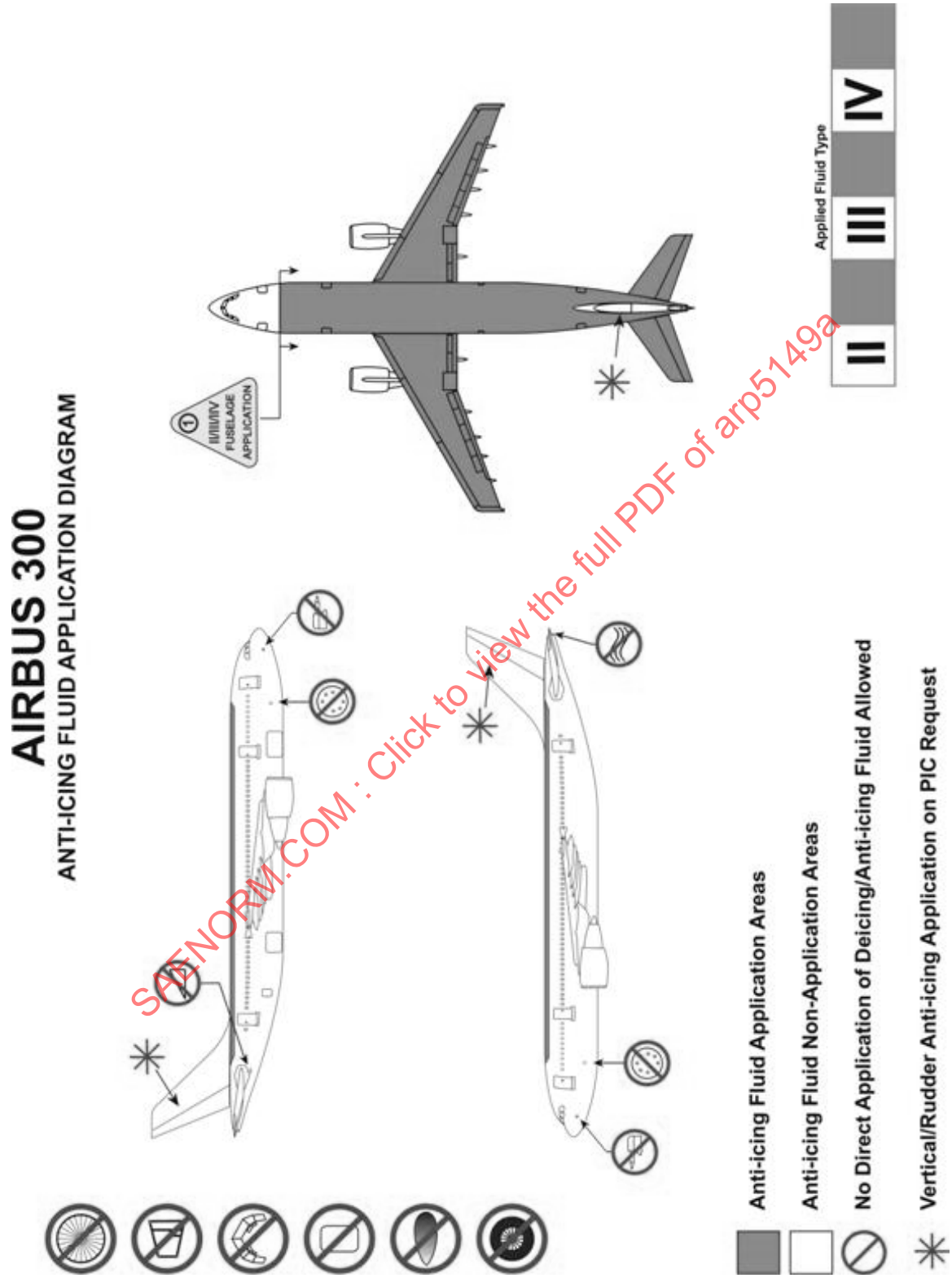
Do not apply undiluted Type II or IV fluids forward of the front cabin entry door. Do not apply to windshields or windscreens.

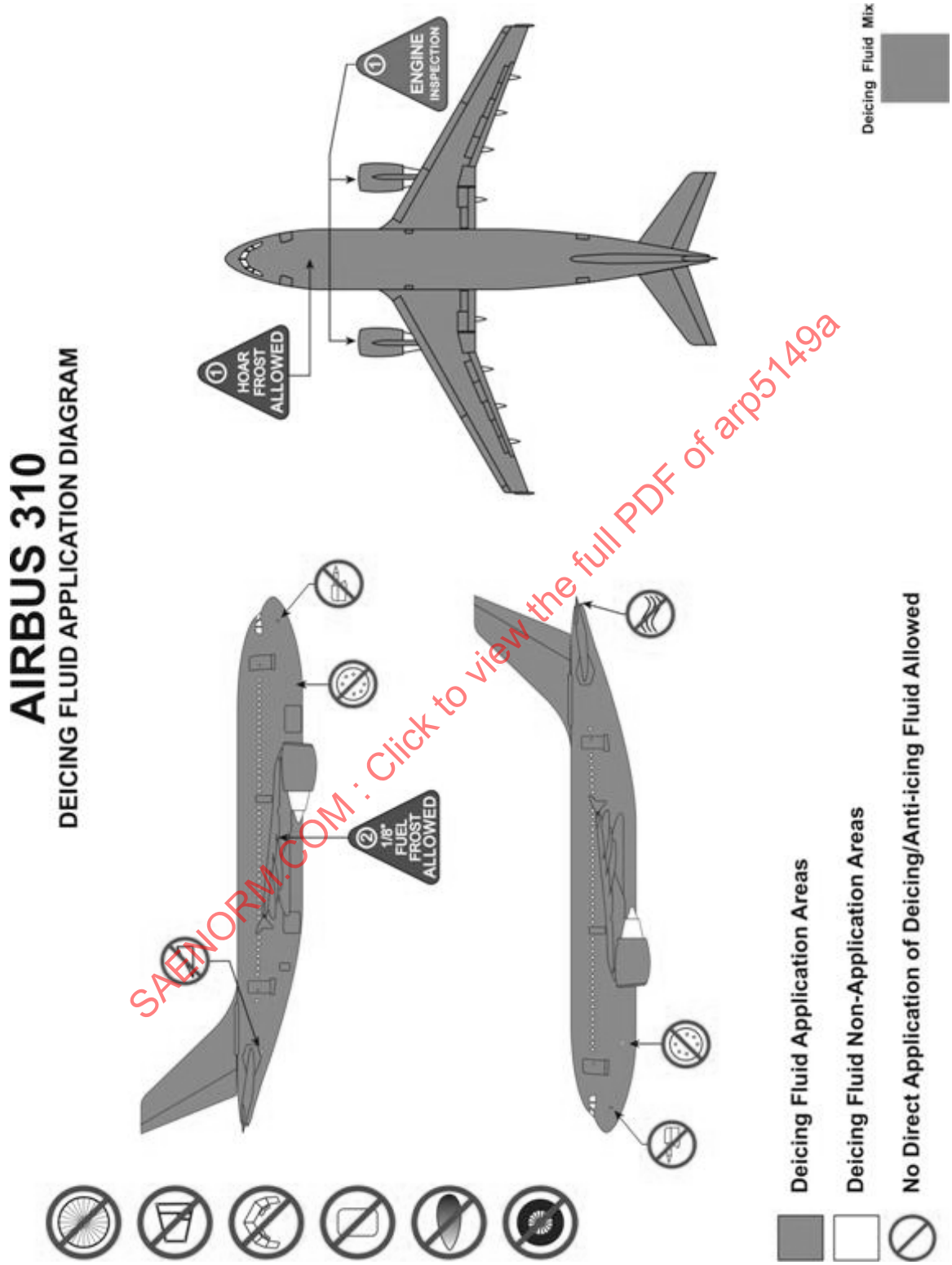
Engine bleed air must be shut off during deicing. Aircraft cannot be deiced with engines running.

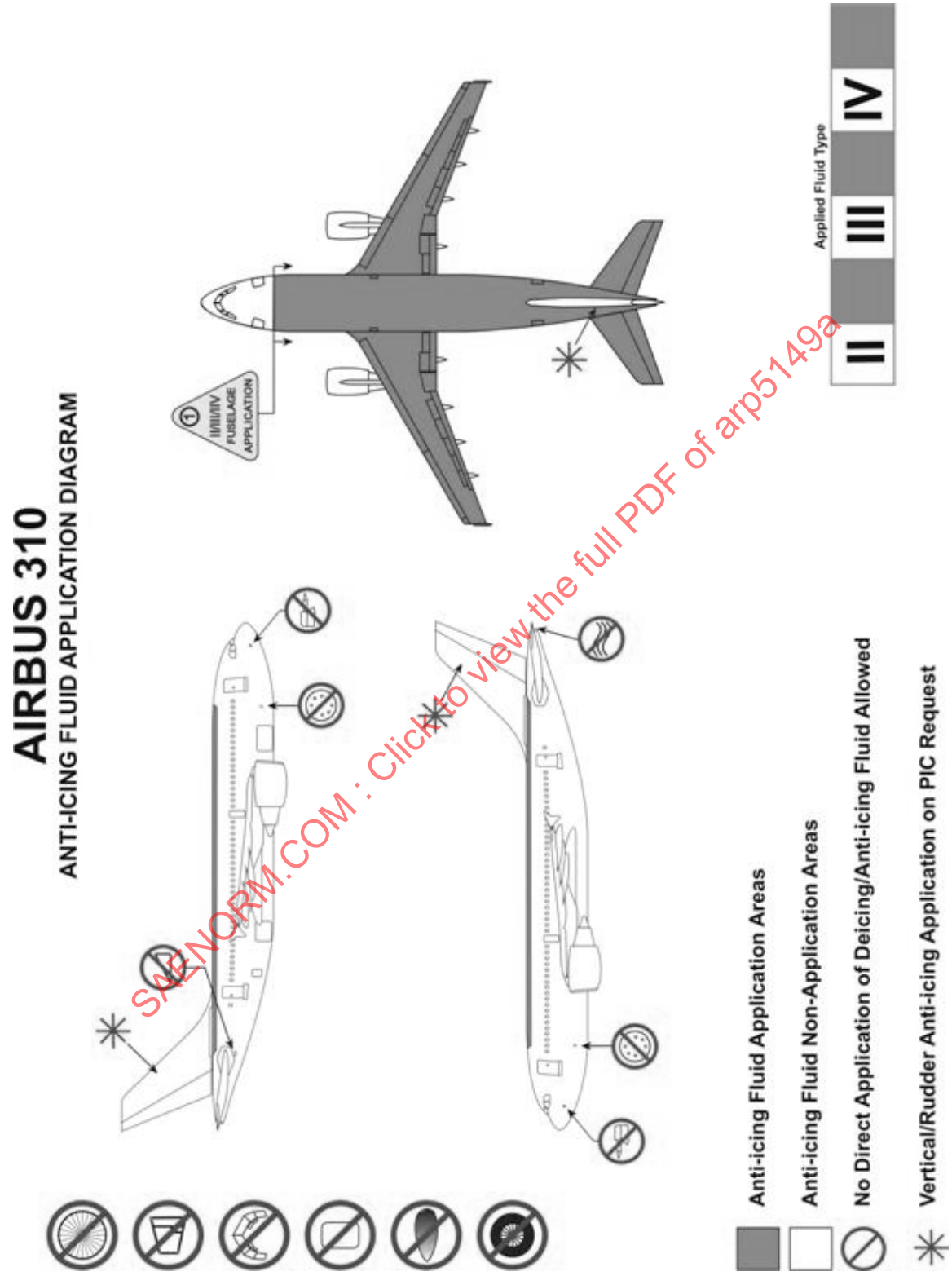
Engine jet blast at idle thrust to severe for safe deicing operations. Aircraft cannot be deiced with engines running.

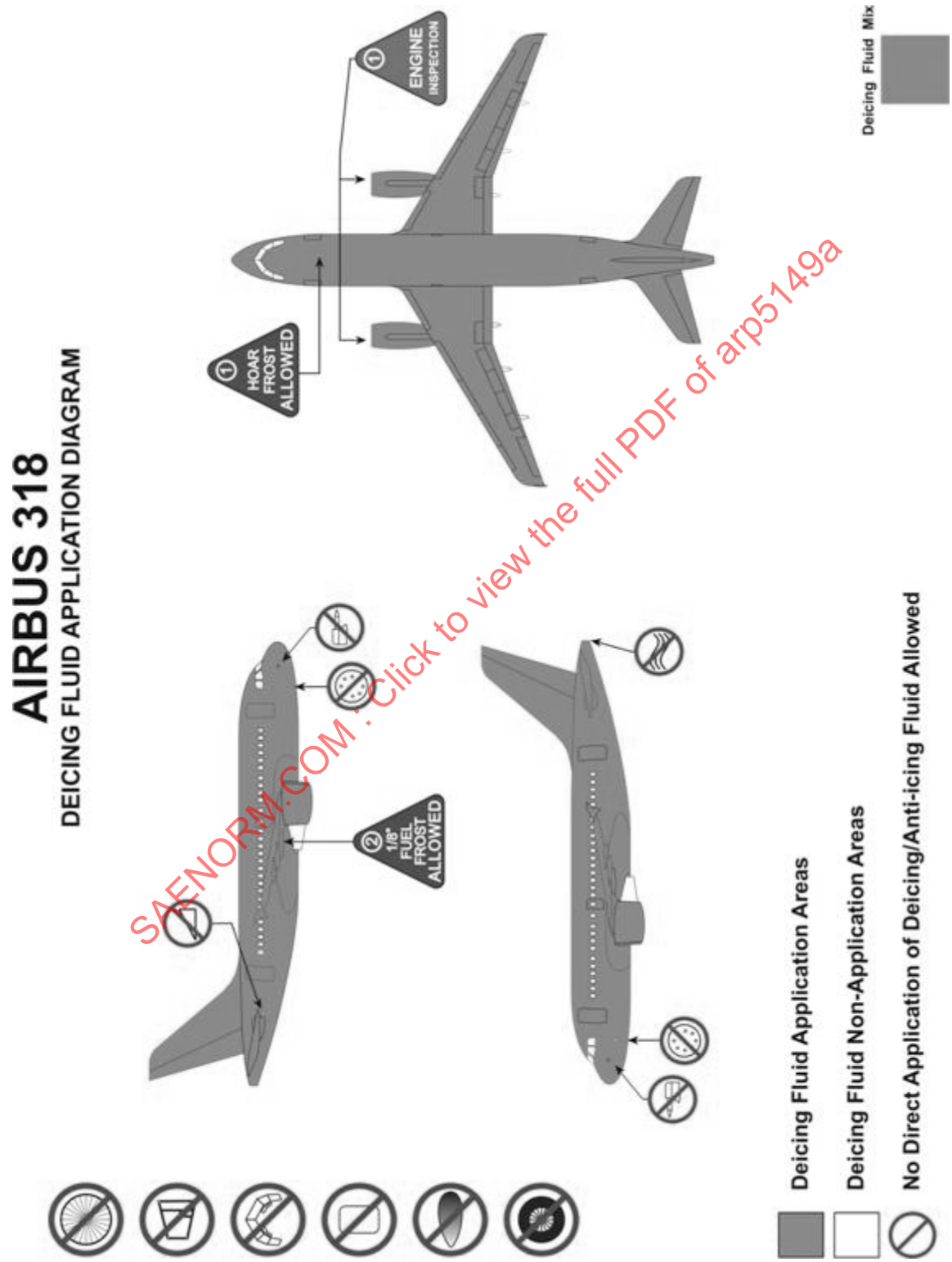
Check wing's upper surface to confirm that ice is not present. A physical check must be conducted of the wings upper surface at inboard end of wing fuel tank.

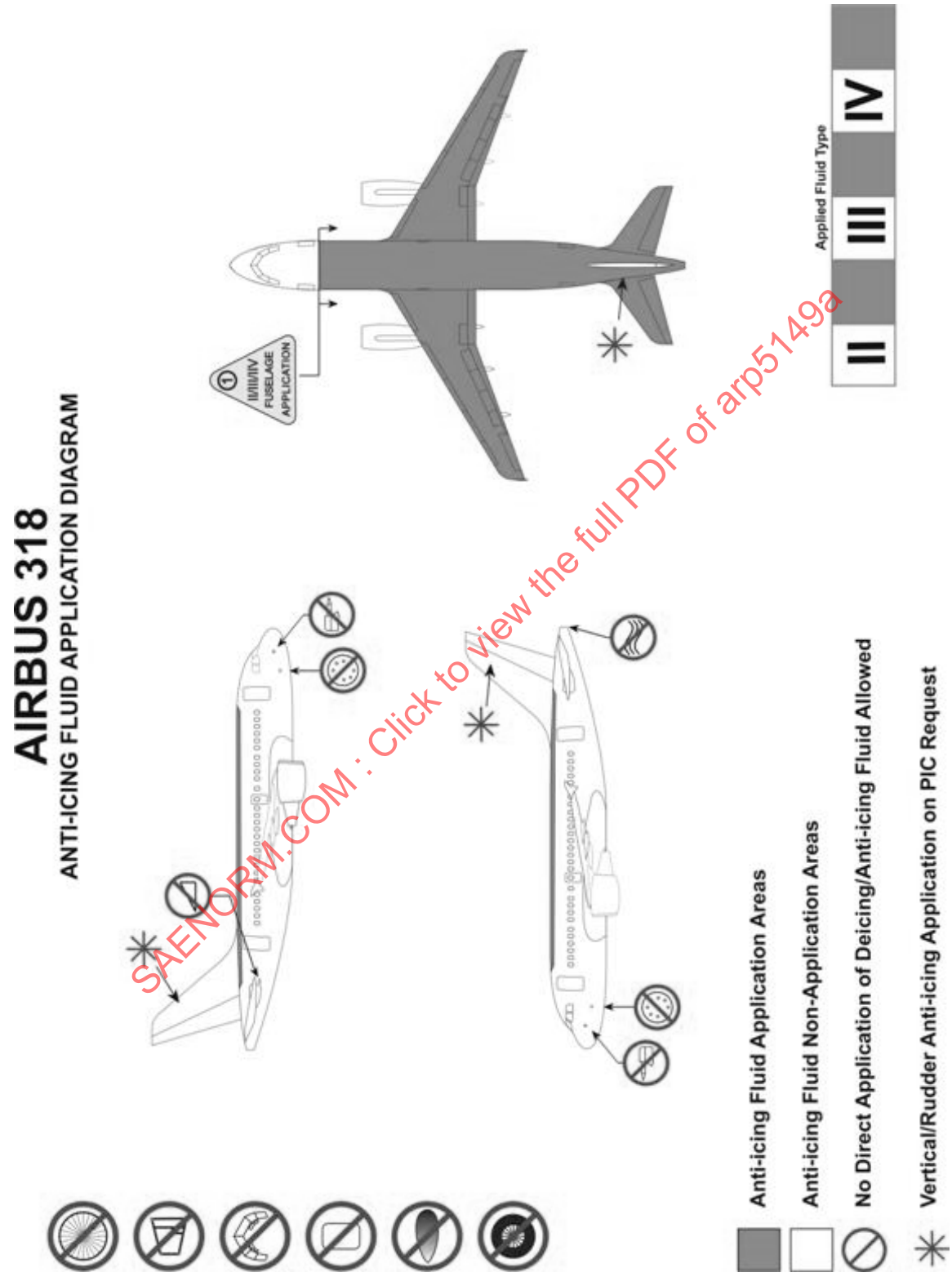


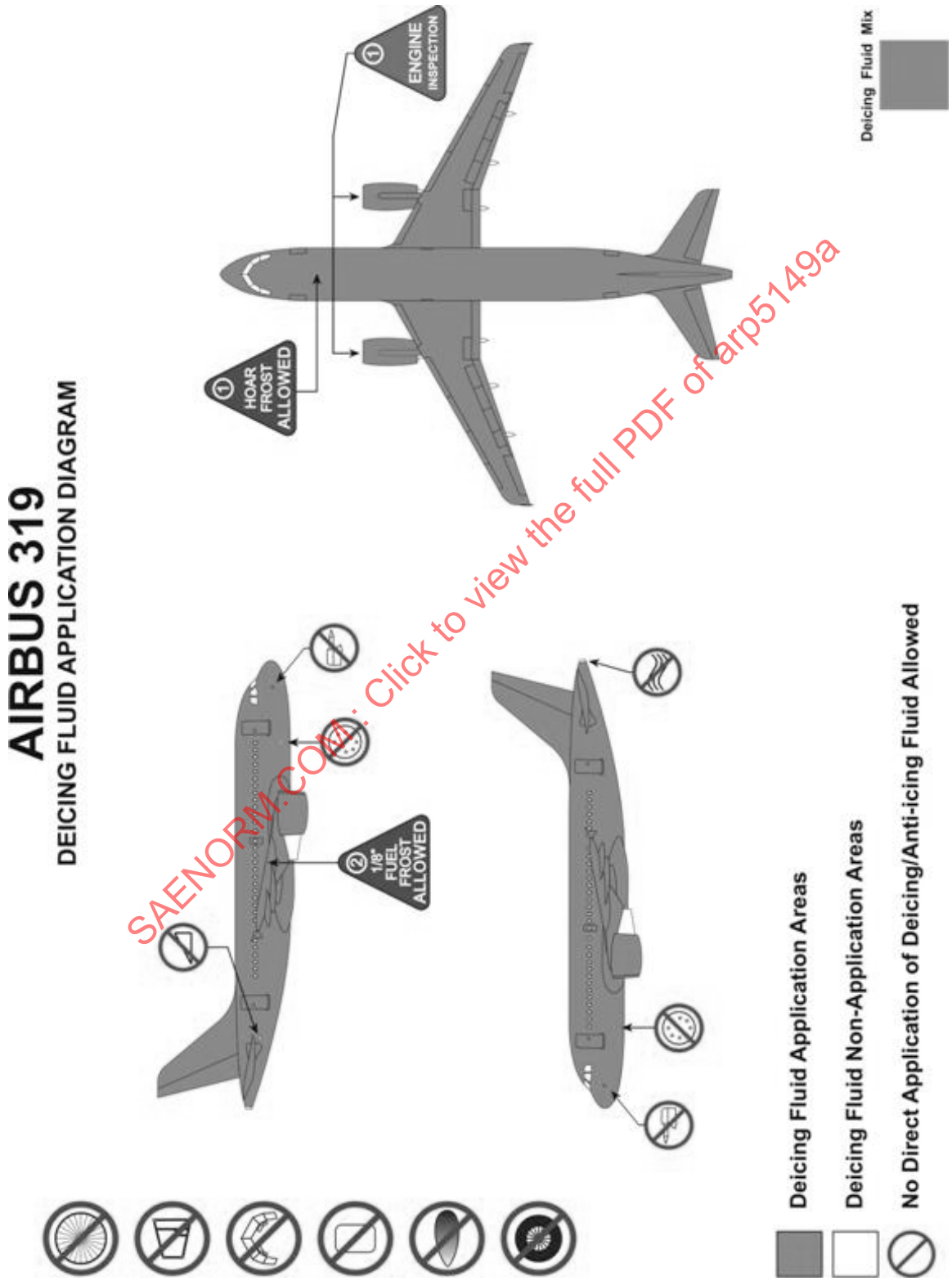


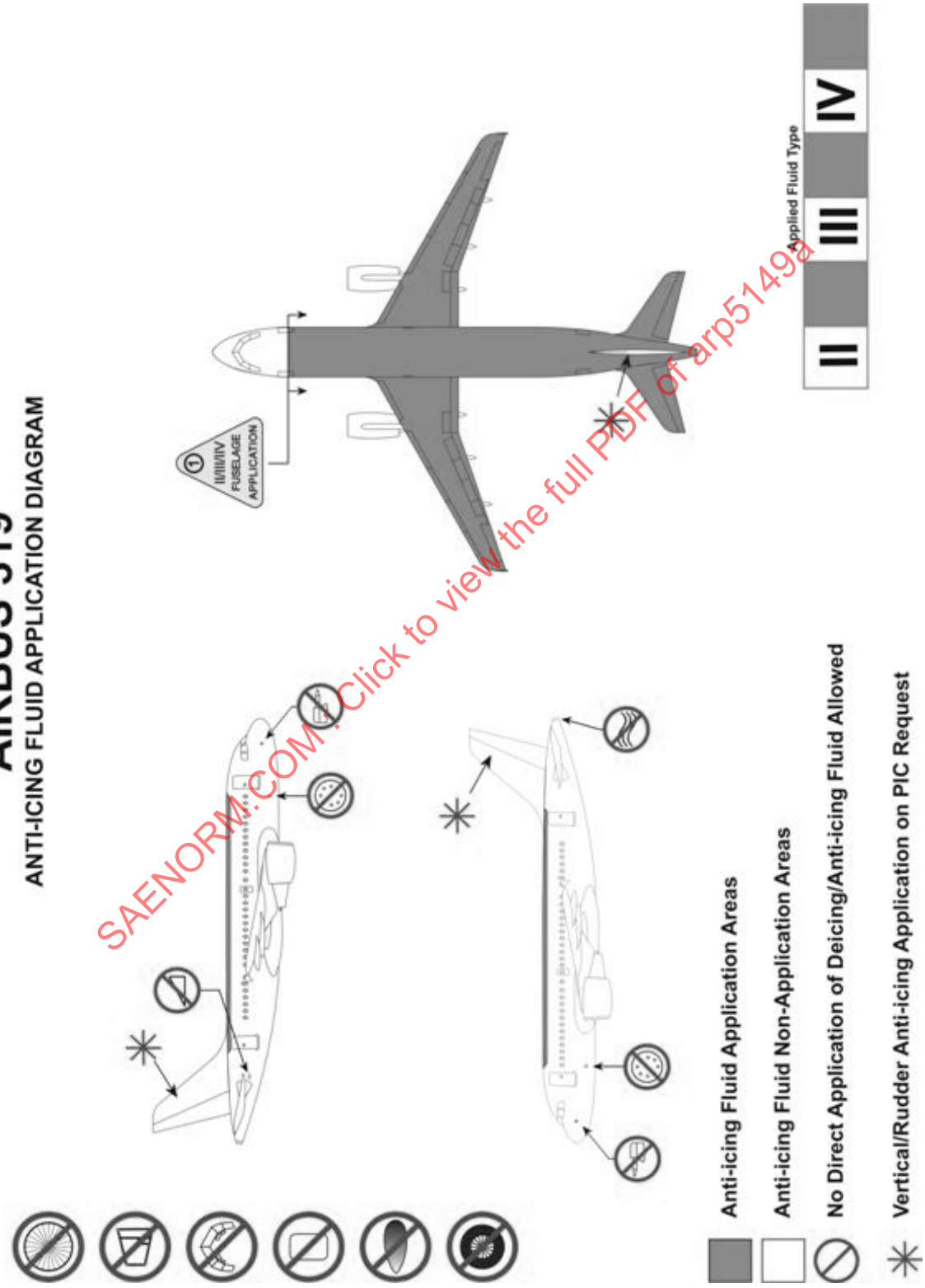


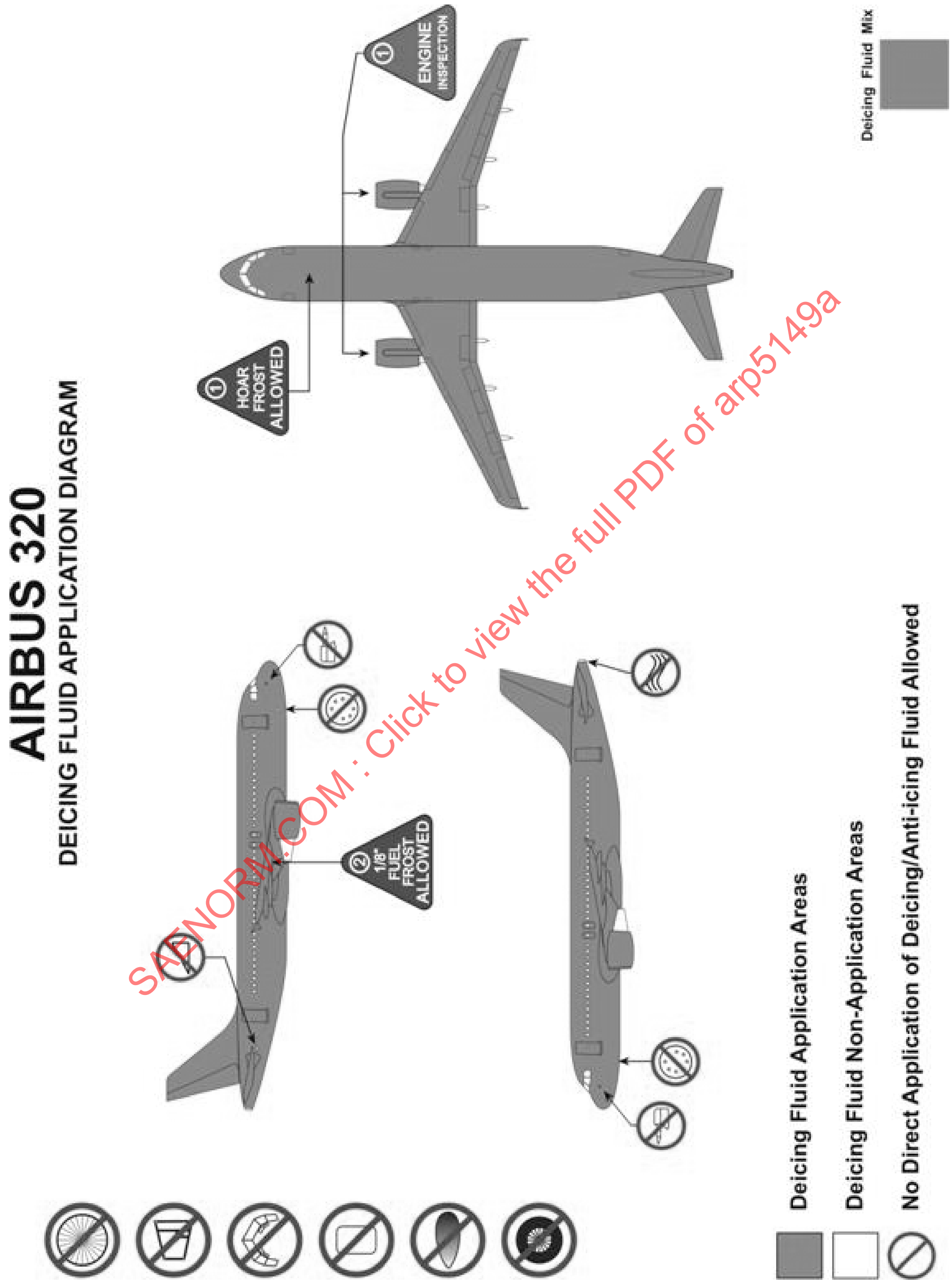


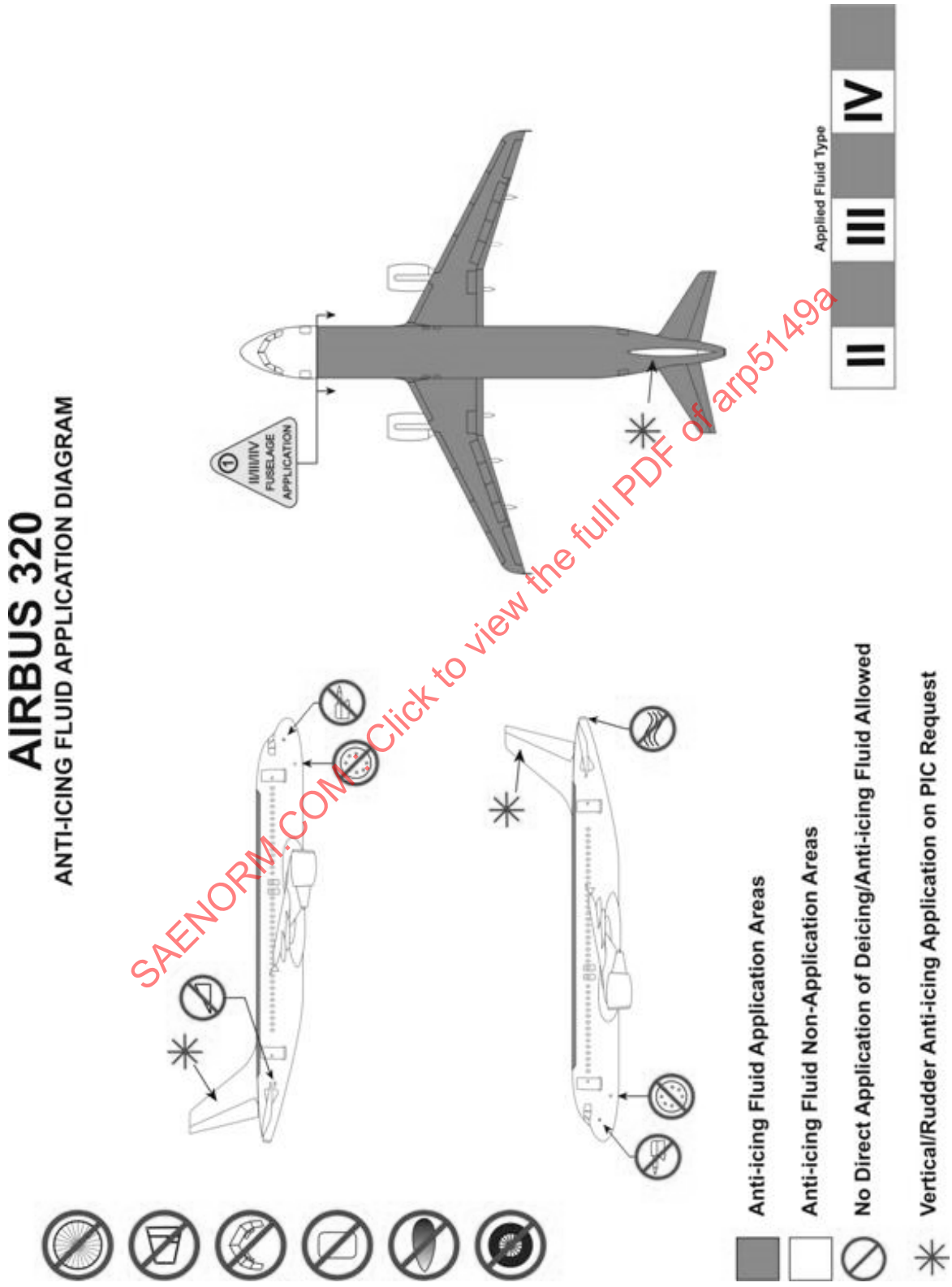


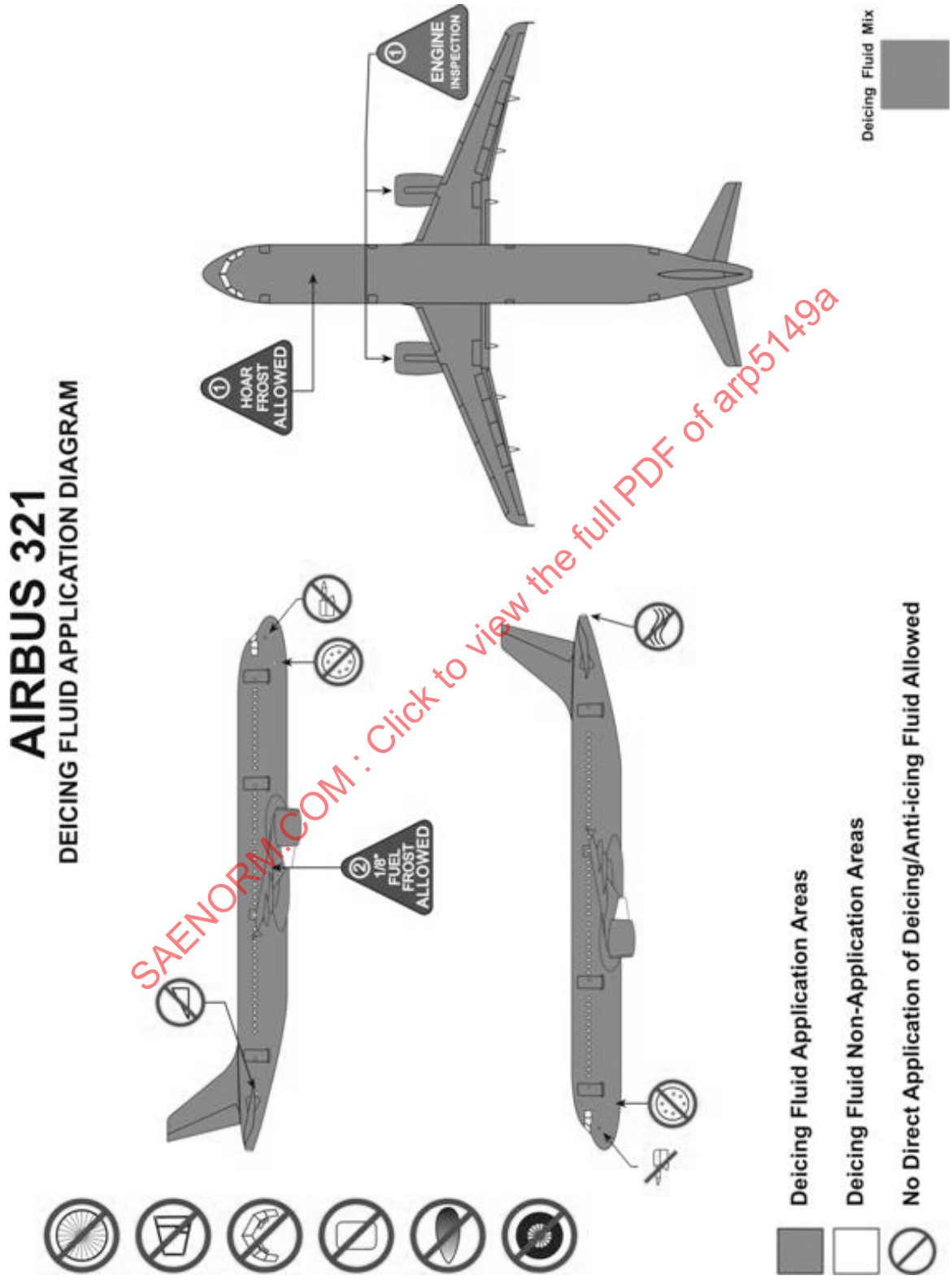






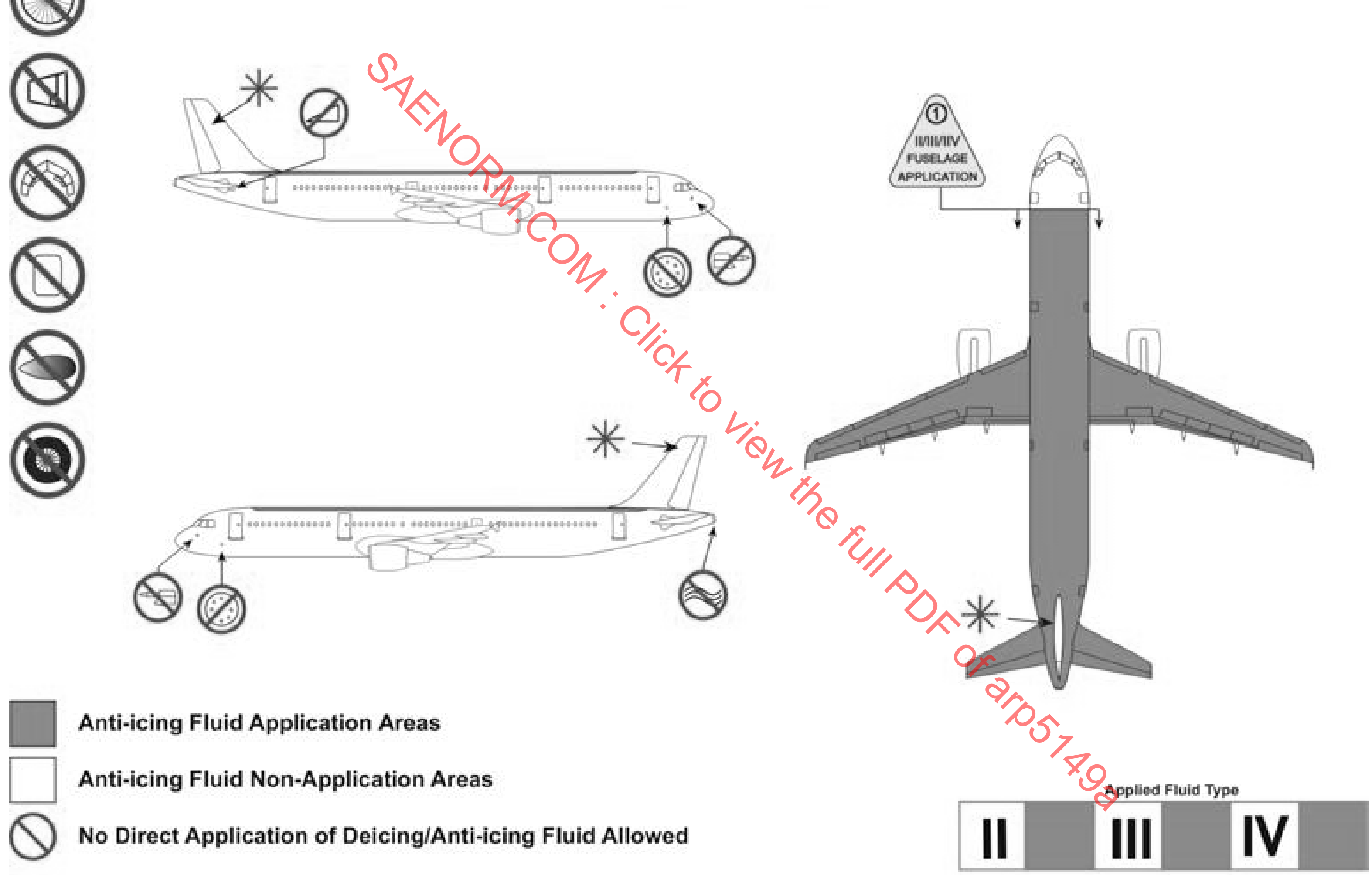






AIRBUS 321

ANTI-ICING FLUID APPLICATION DIAGRAM

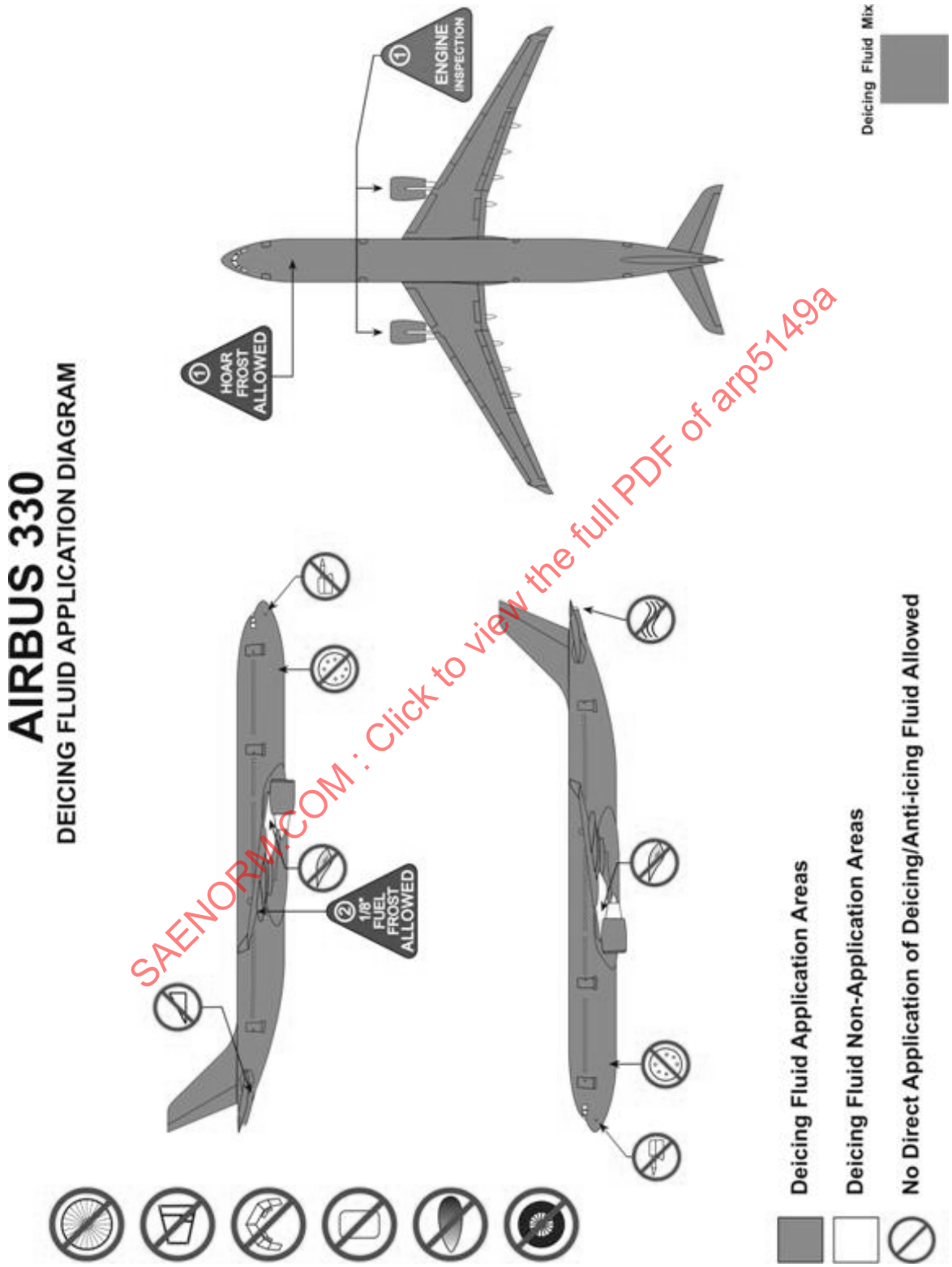


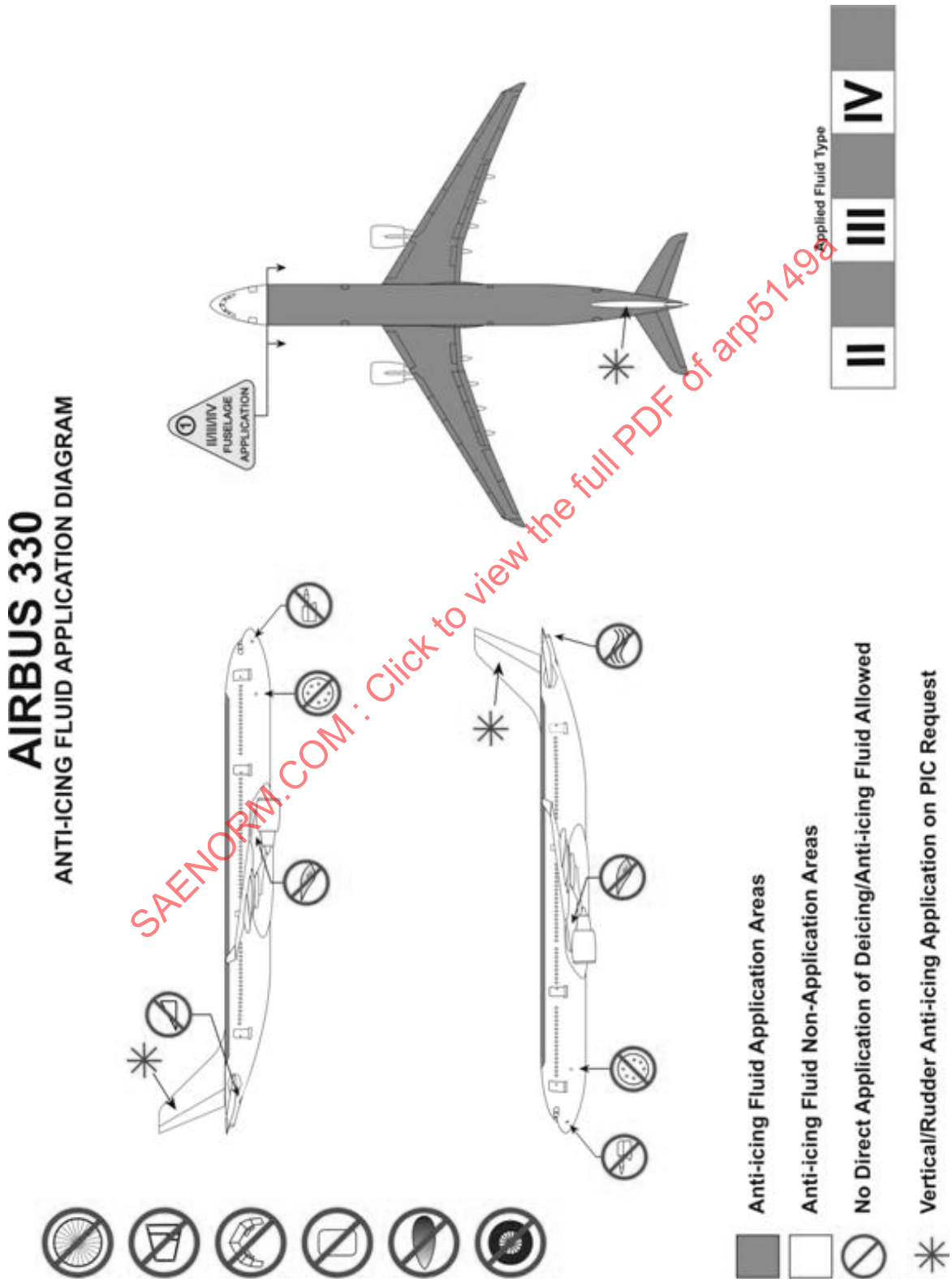
Anti-icing Fluid Application Areas

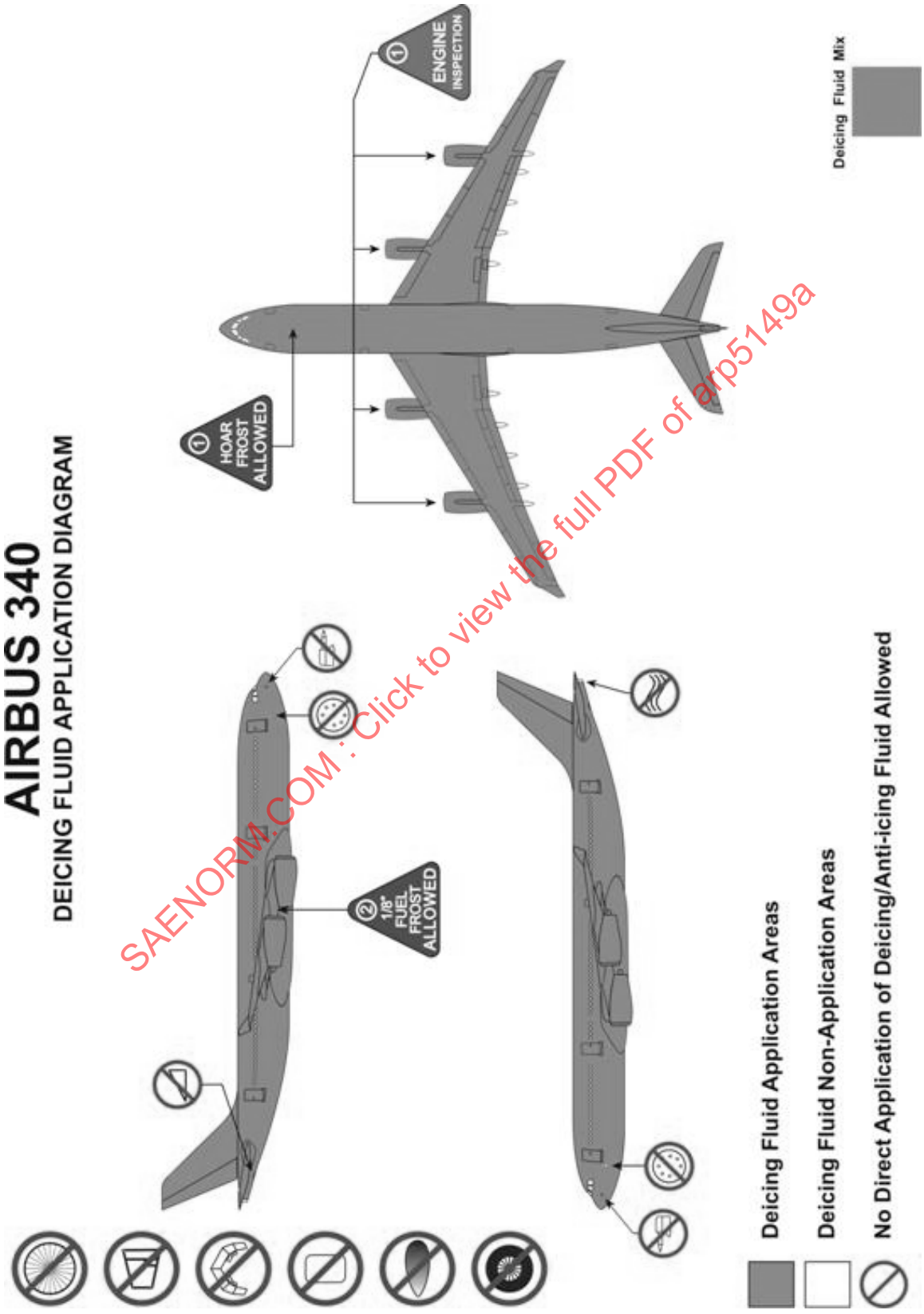
Anti-icing Fluid Non-Application Areas

No Direct Application of Deicing/Anti-icing Fluid Allowed

Vertical/Rudder Anti-icing Application on PIC Request

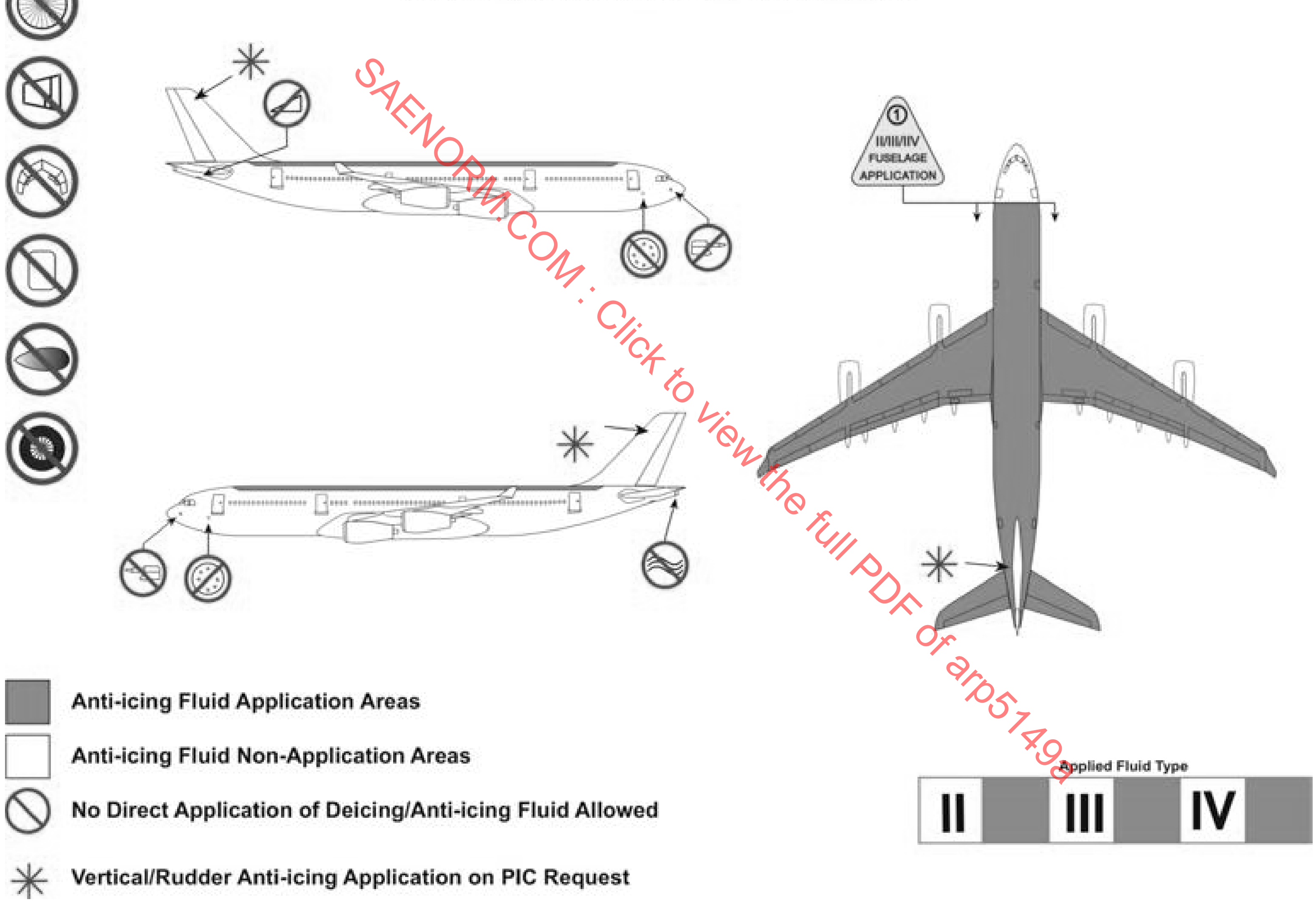


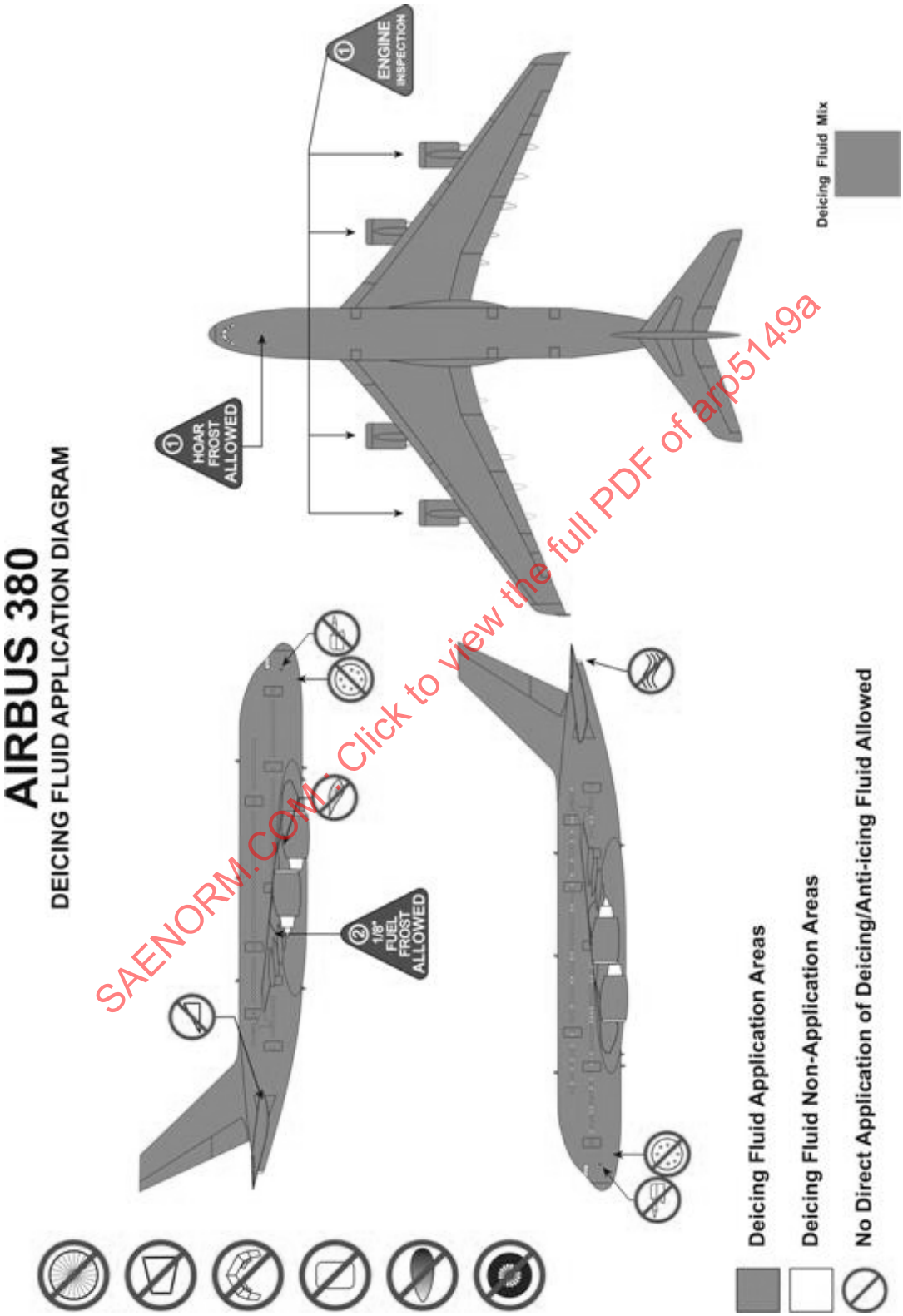




AIRBUS 340

ANTI-ICING FLUID APPLICATION DIAGRAM





AIRBUS 380

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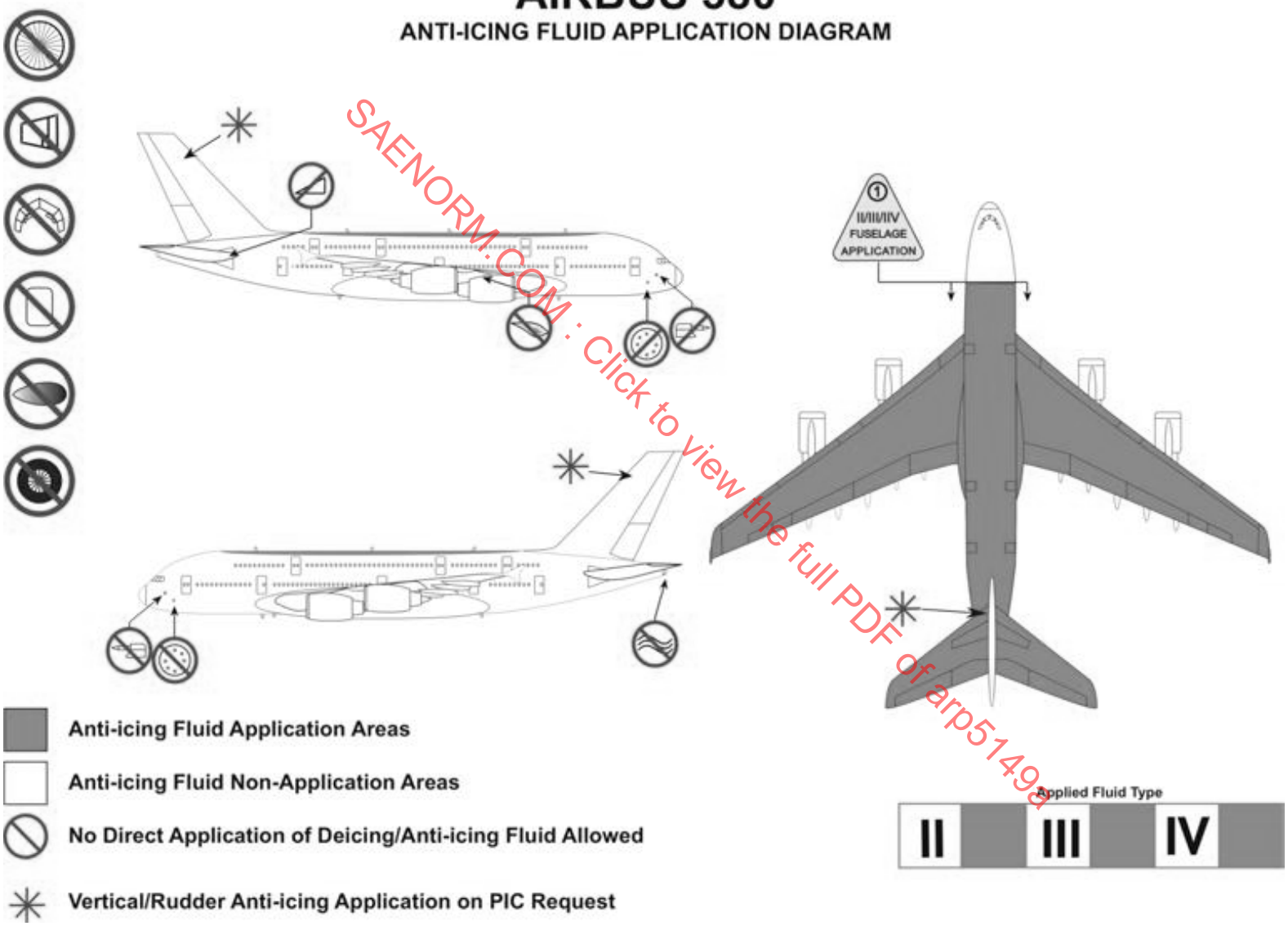
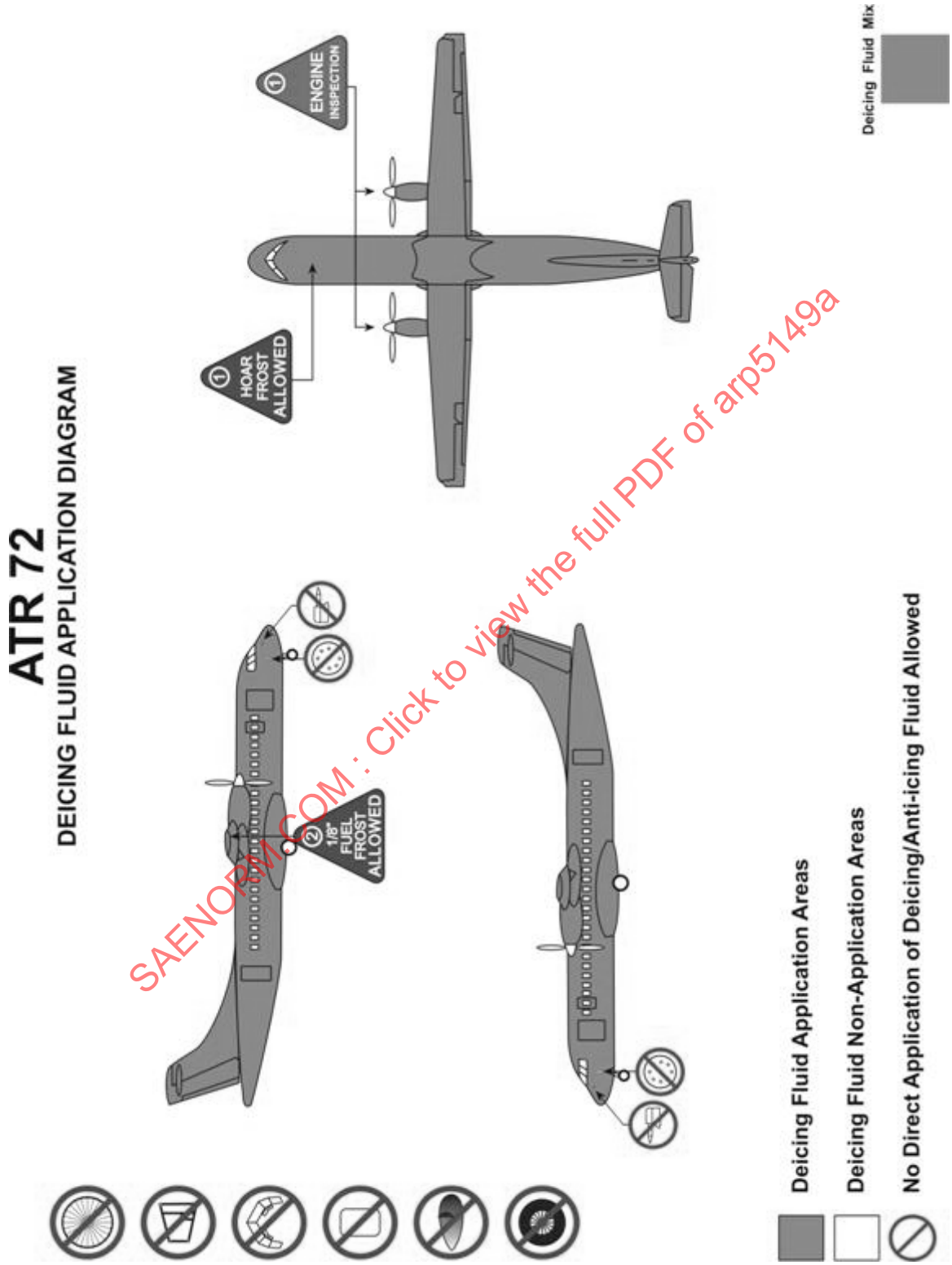
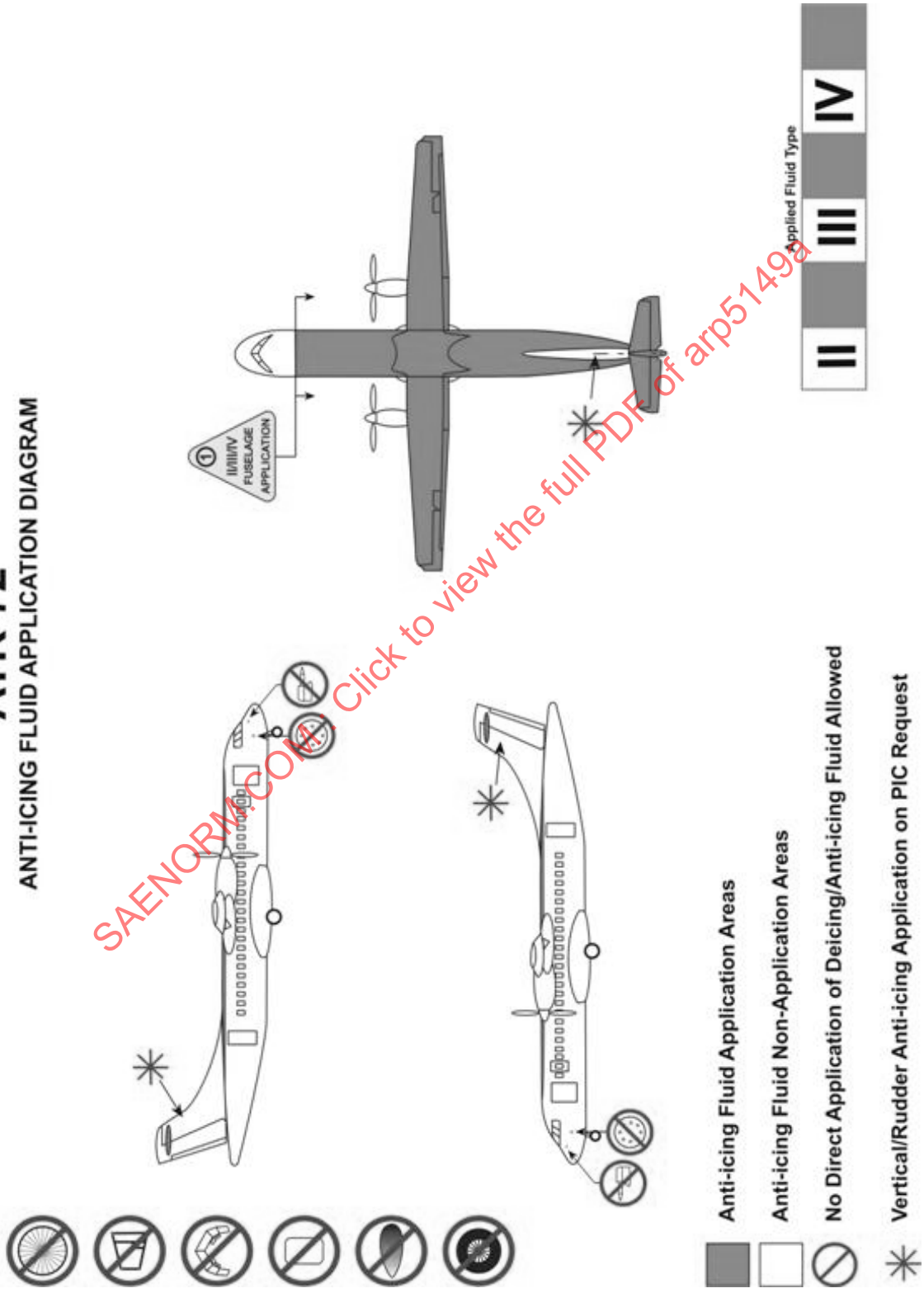
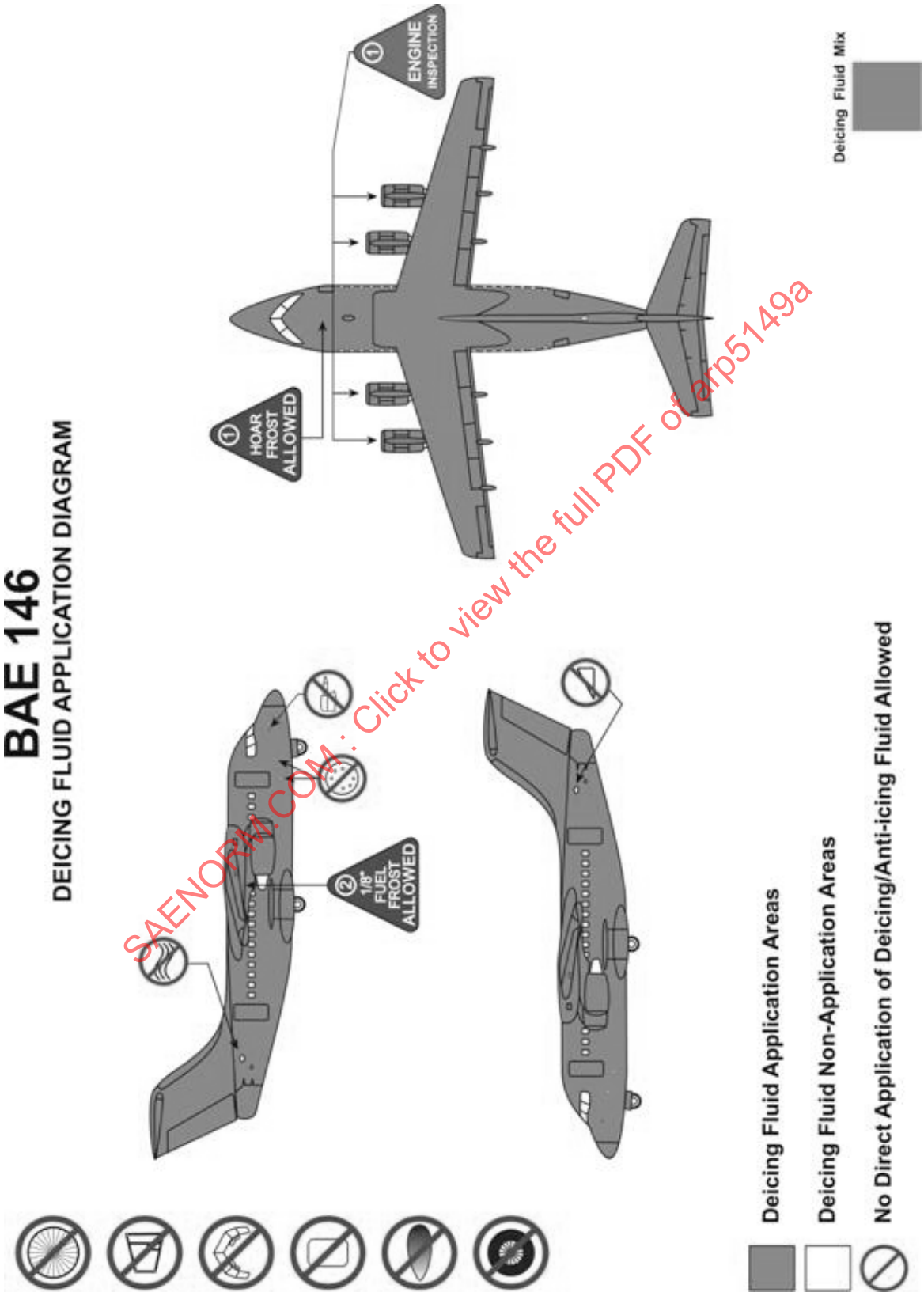


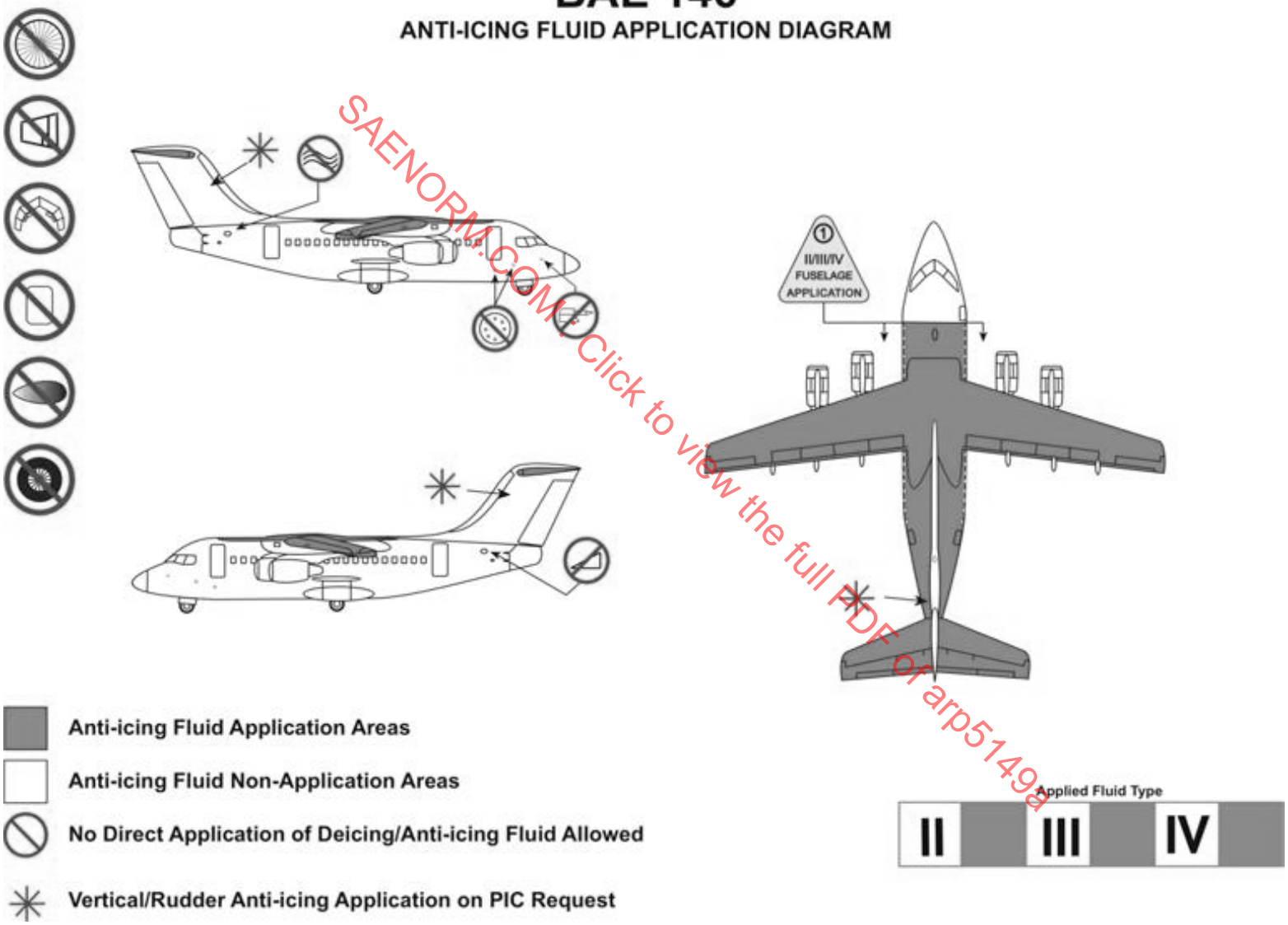


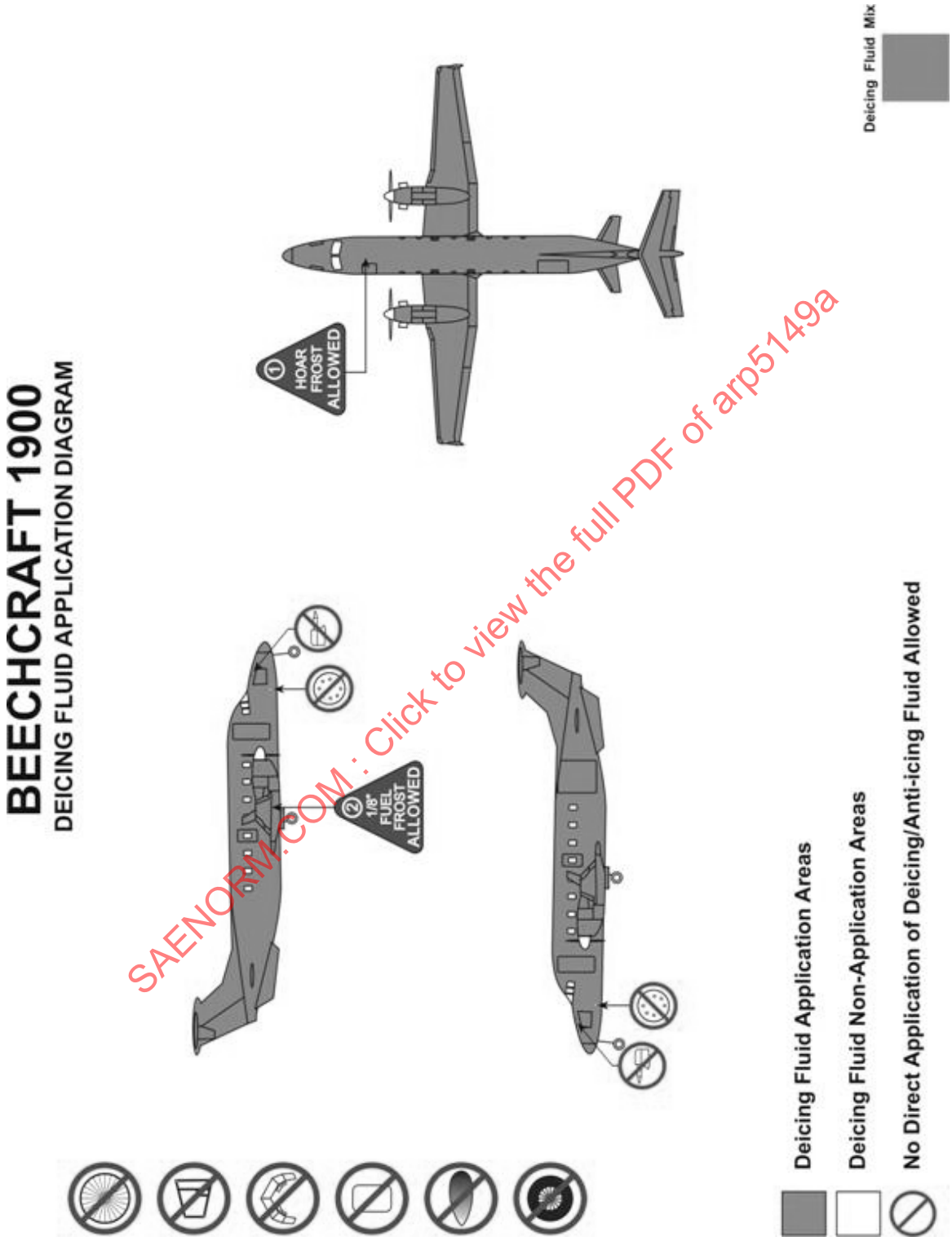




BAE 146

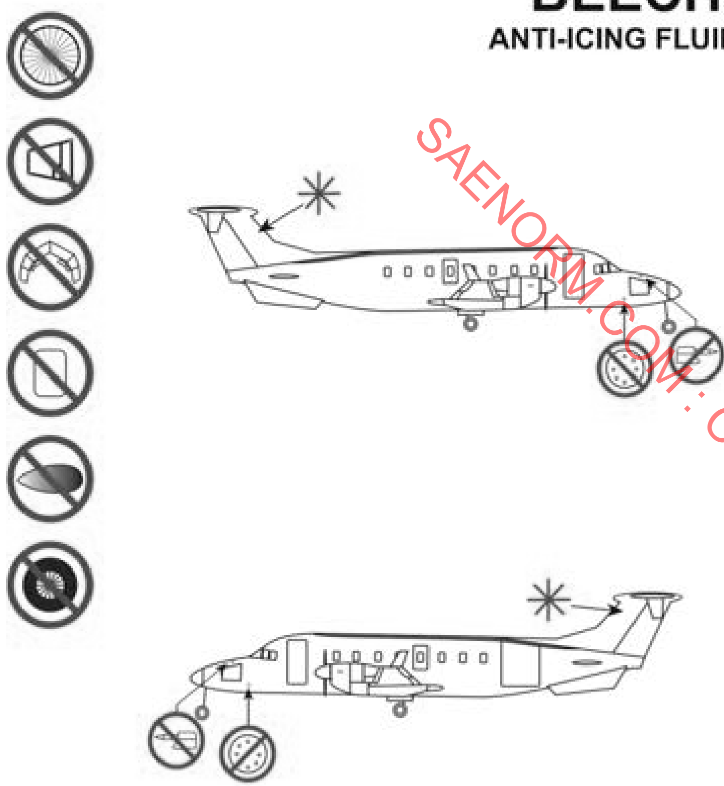
ANTI-ICING FLUID APPLICATION DIAGRAM

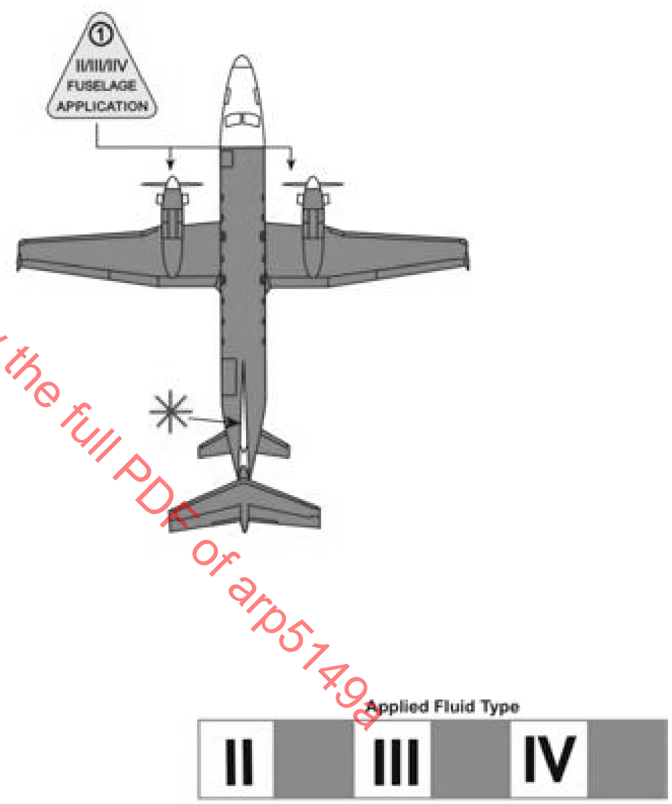




BEECHCRAFT 1900

ANTI-ICING FLUID APPLICATION DIAGRAM





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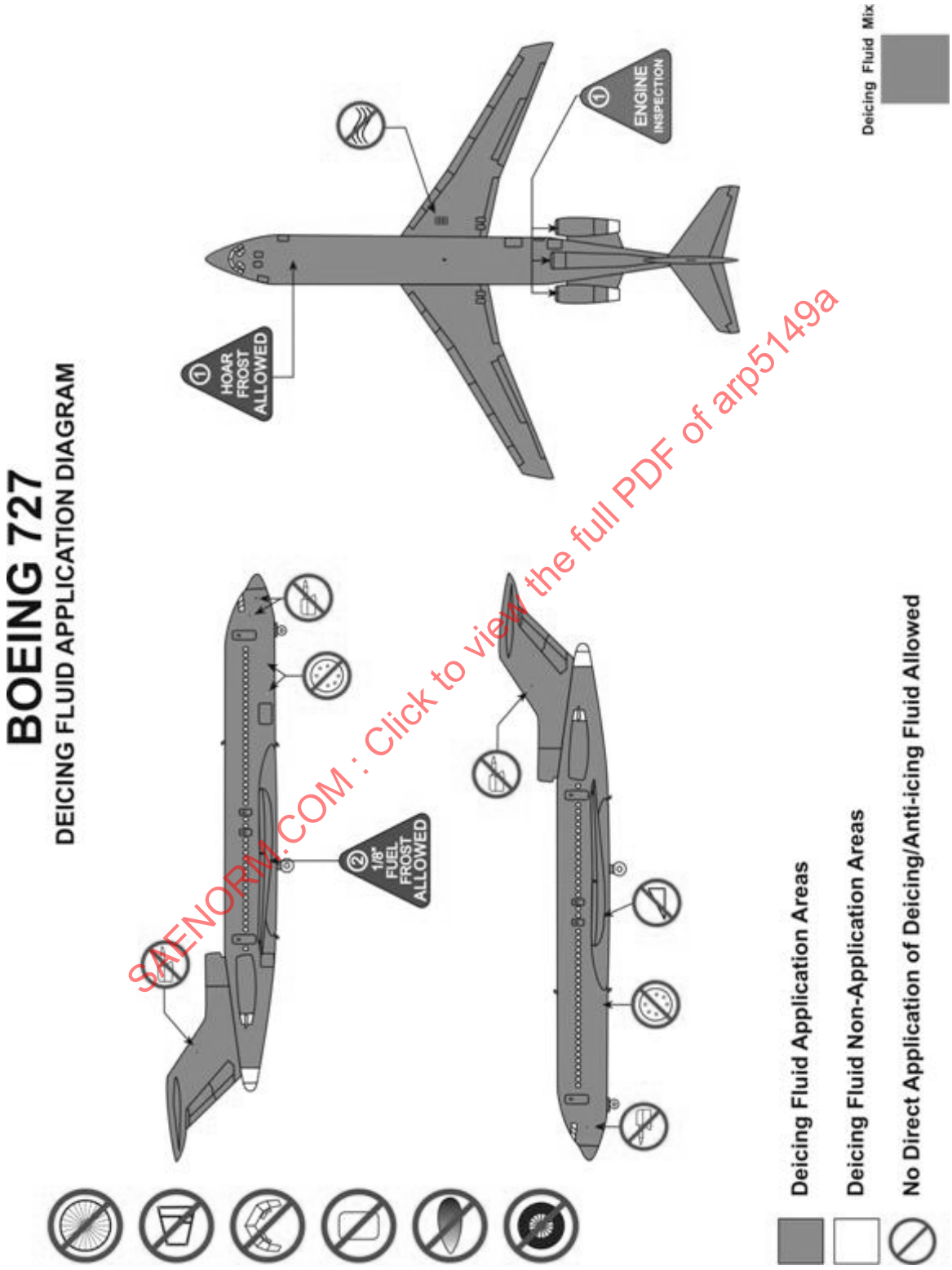
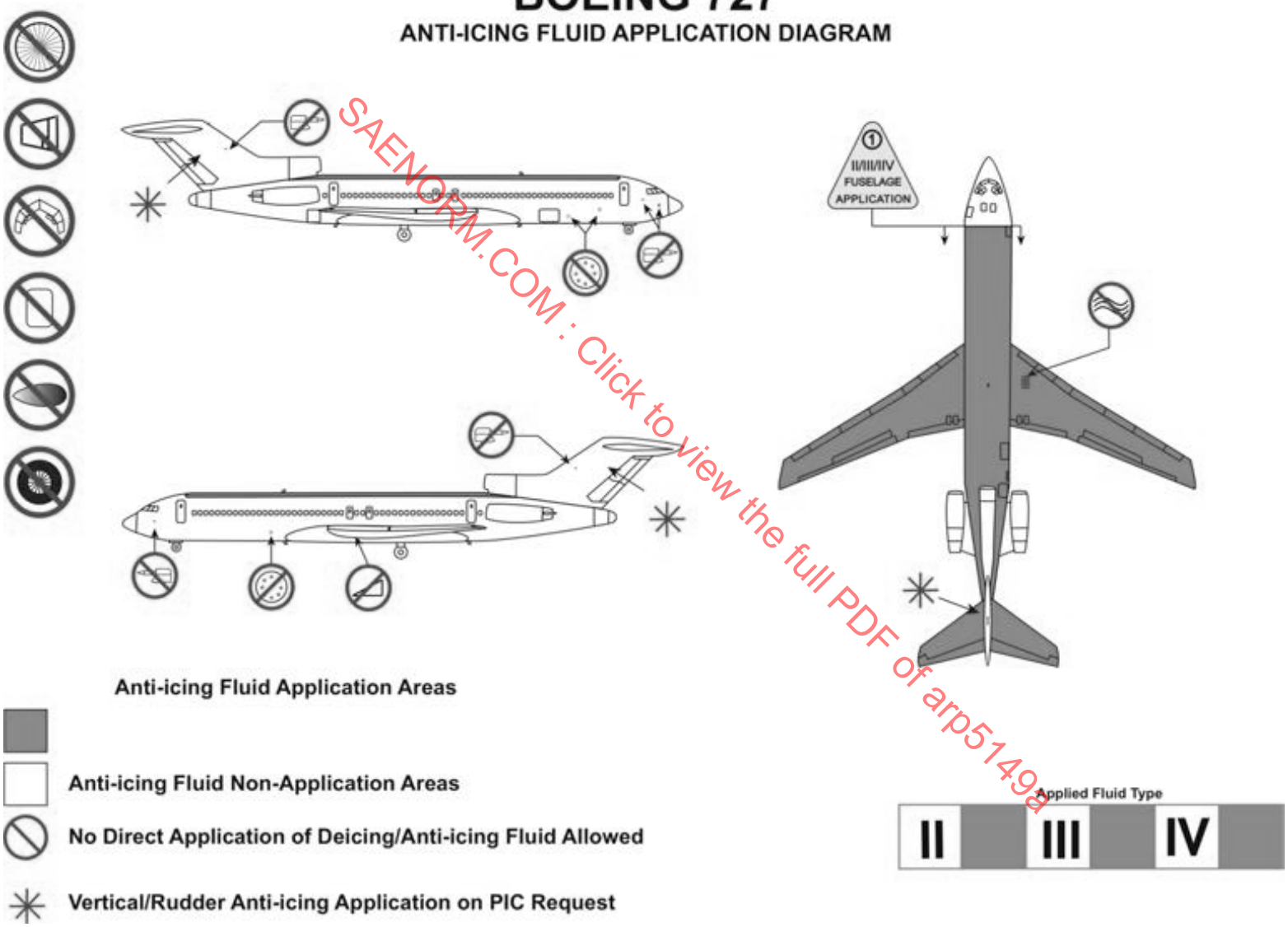
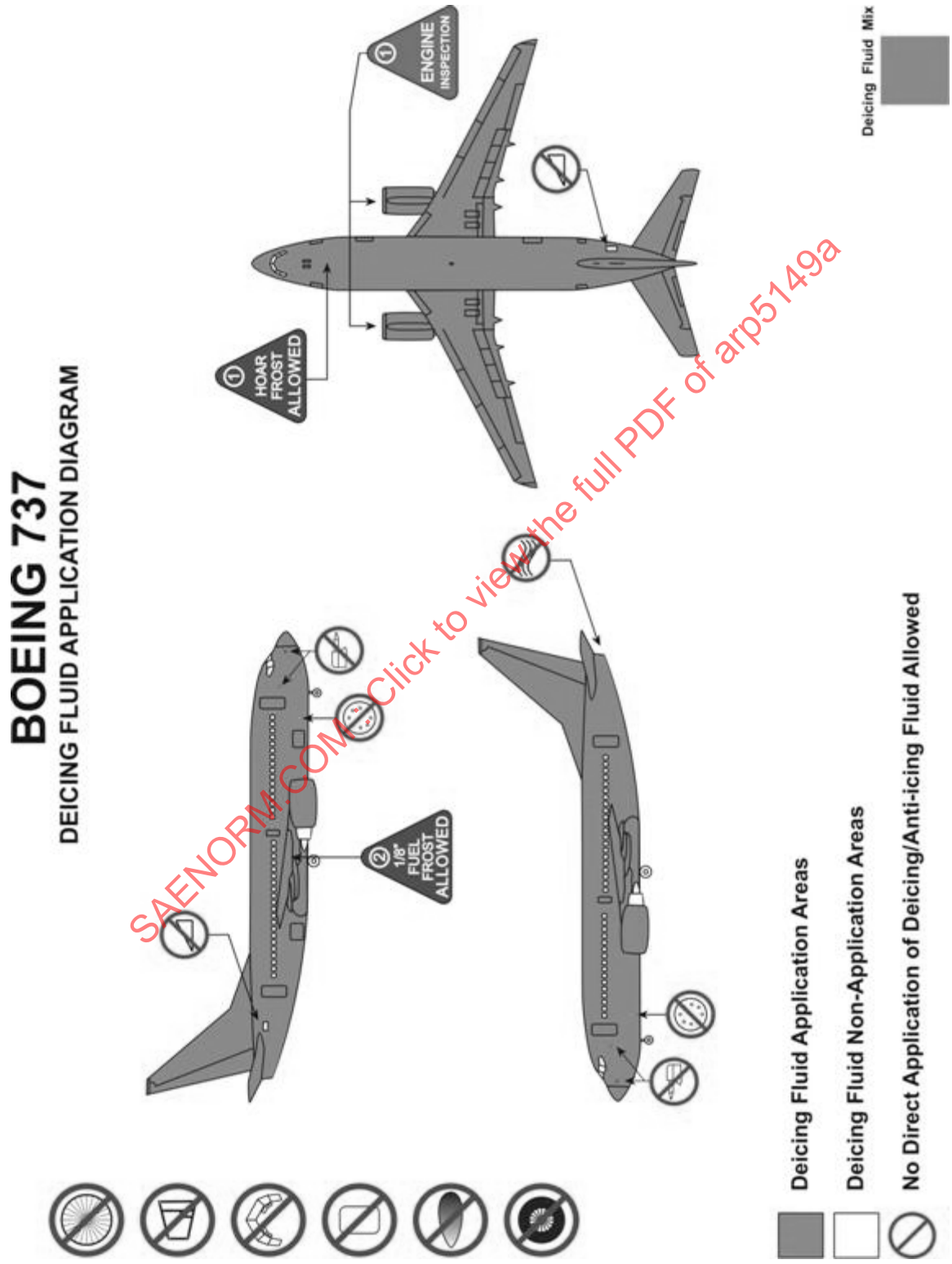
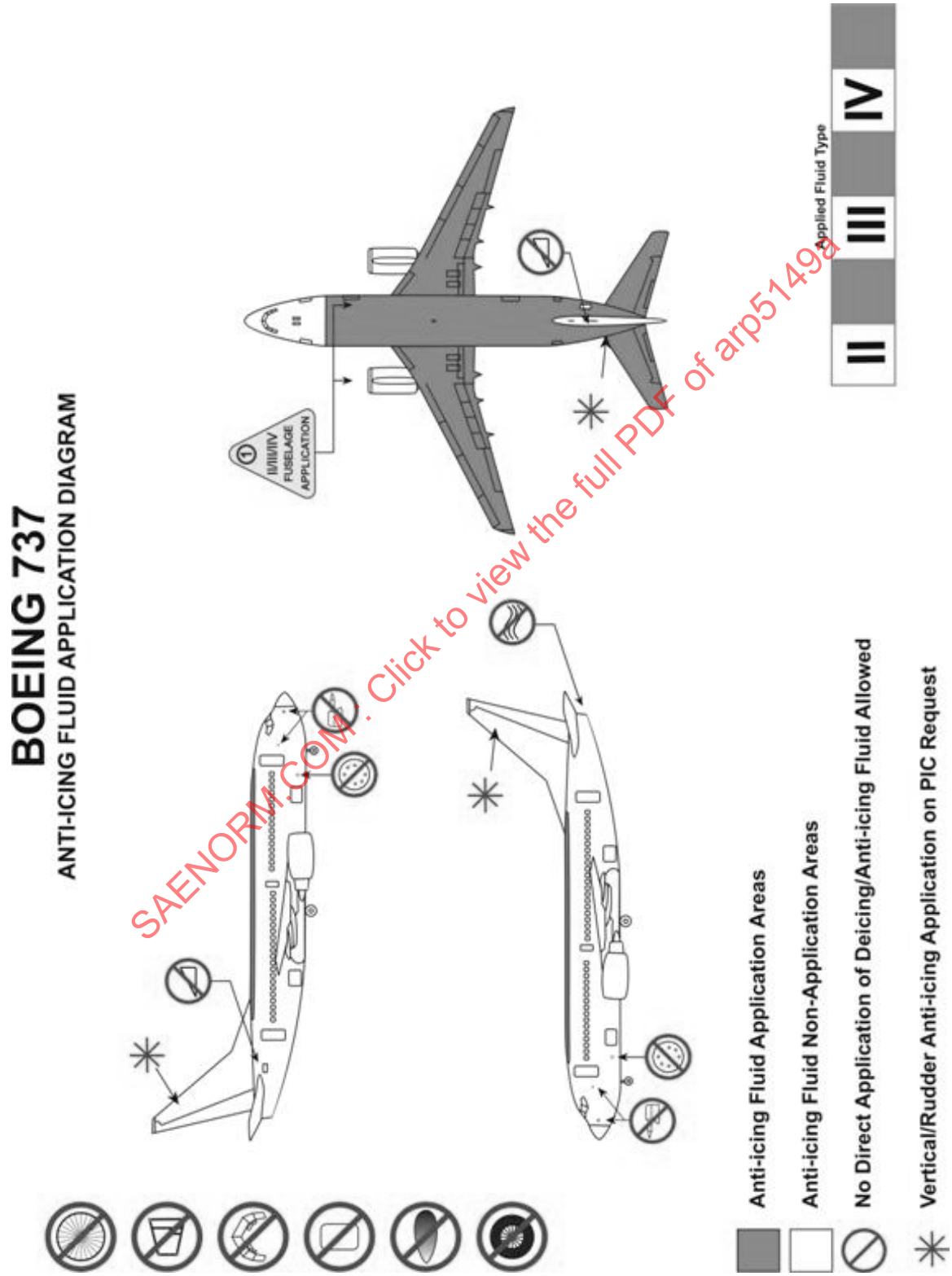


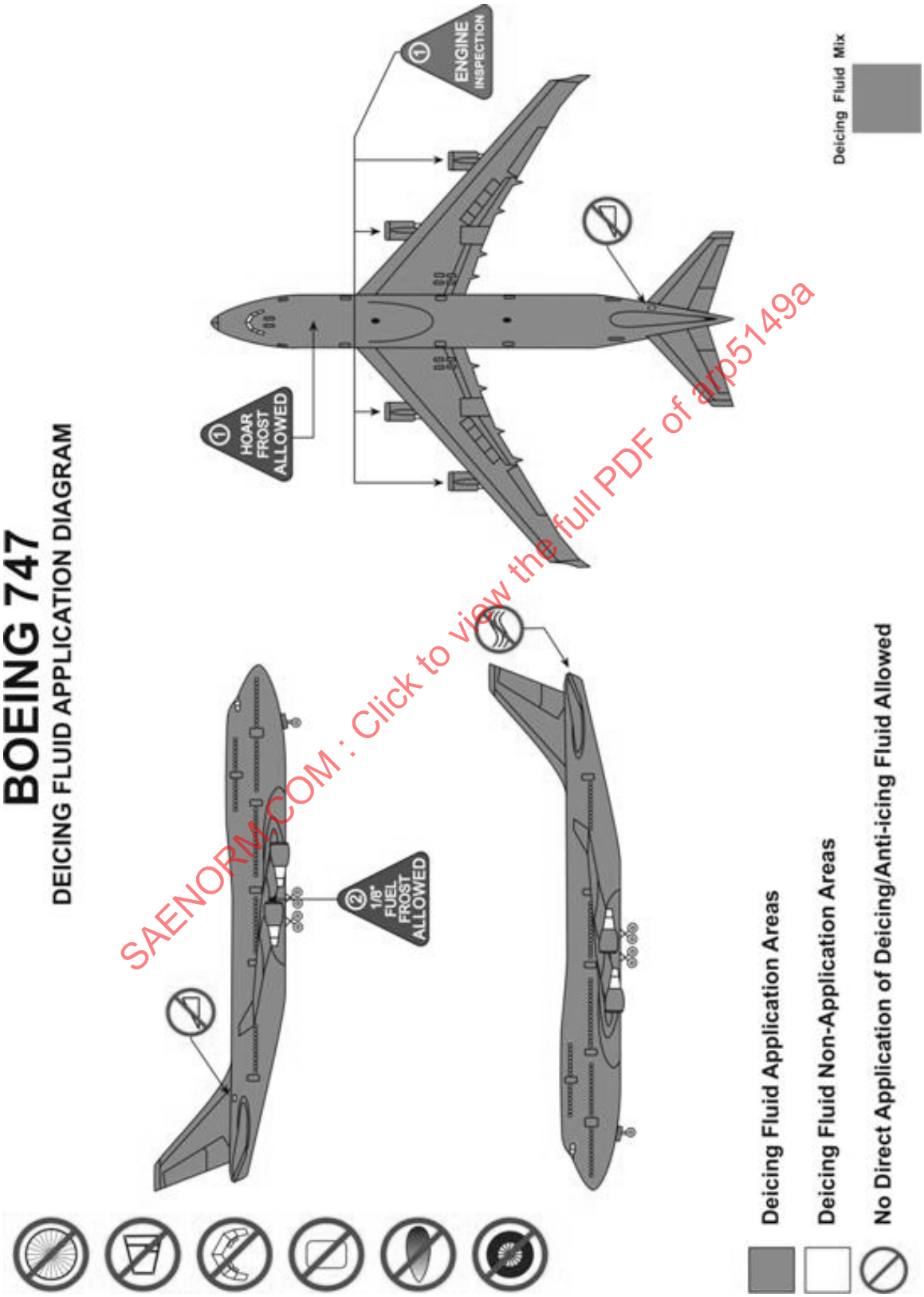
BOEING 727

ANTI-ICING FLUID APPLICATION DIAGRAM



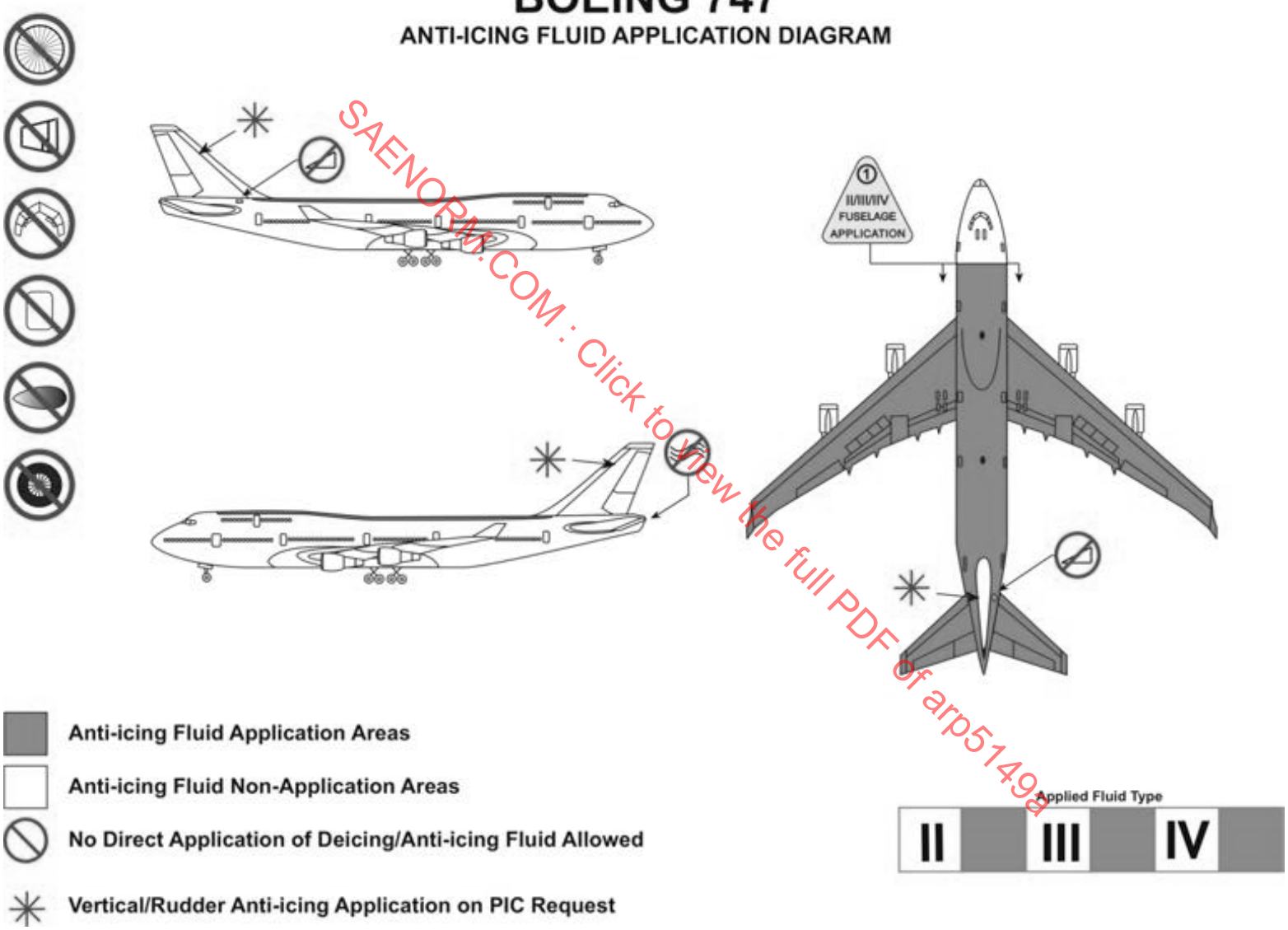


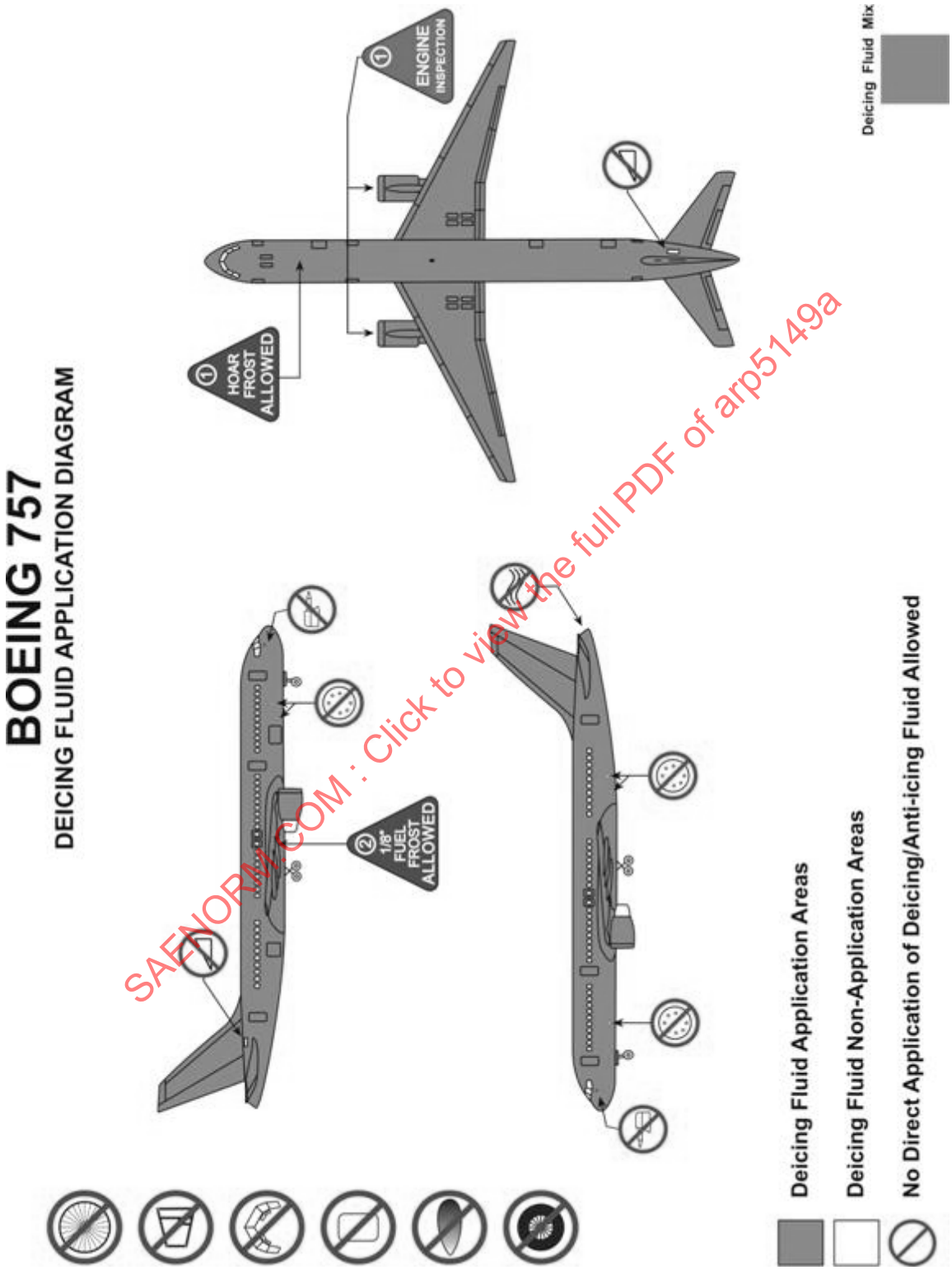




BOEING 747

ANTI-ICING FLUID APPLICATION DIAGRAM





BOEING 757

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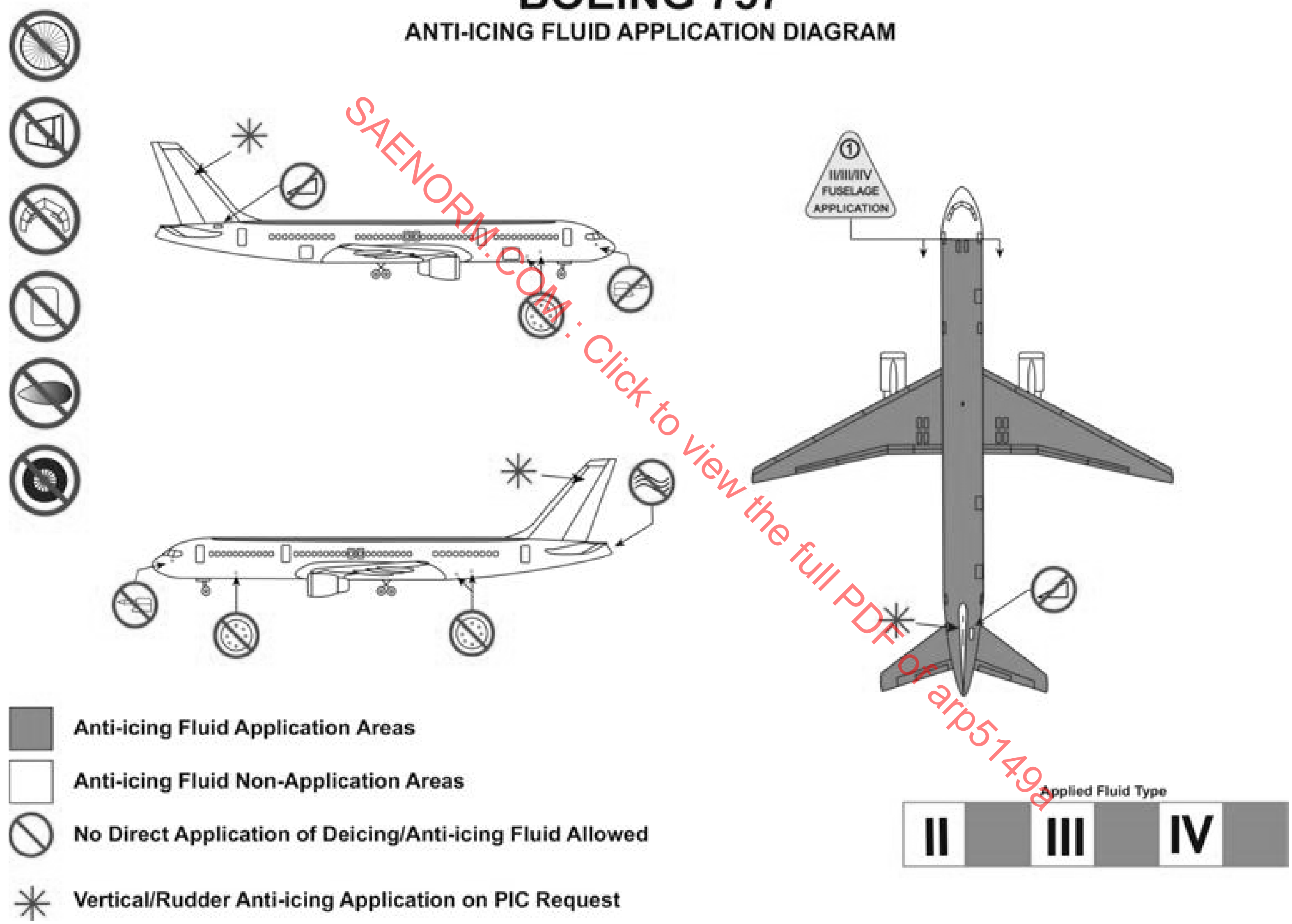

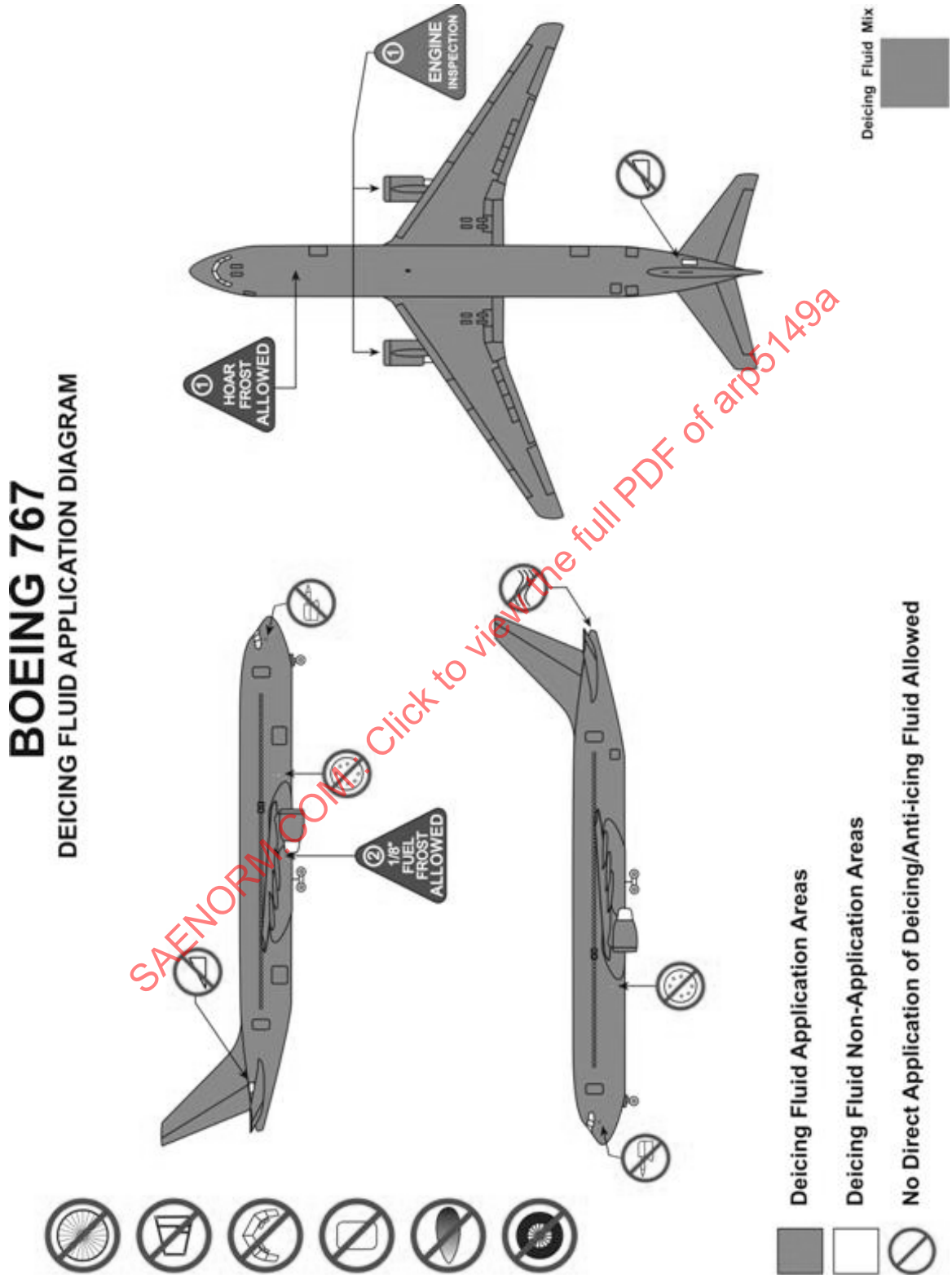

BOEING 767

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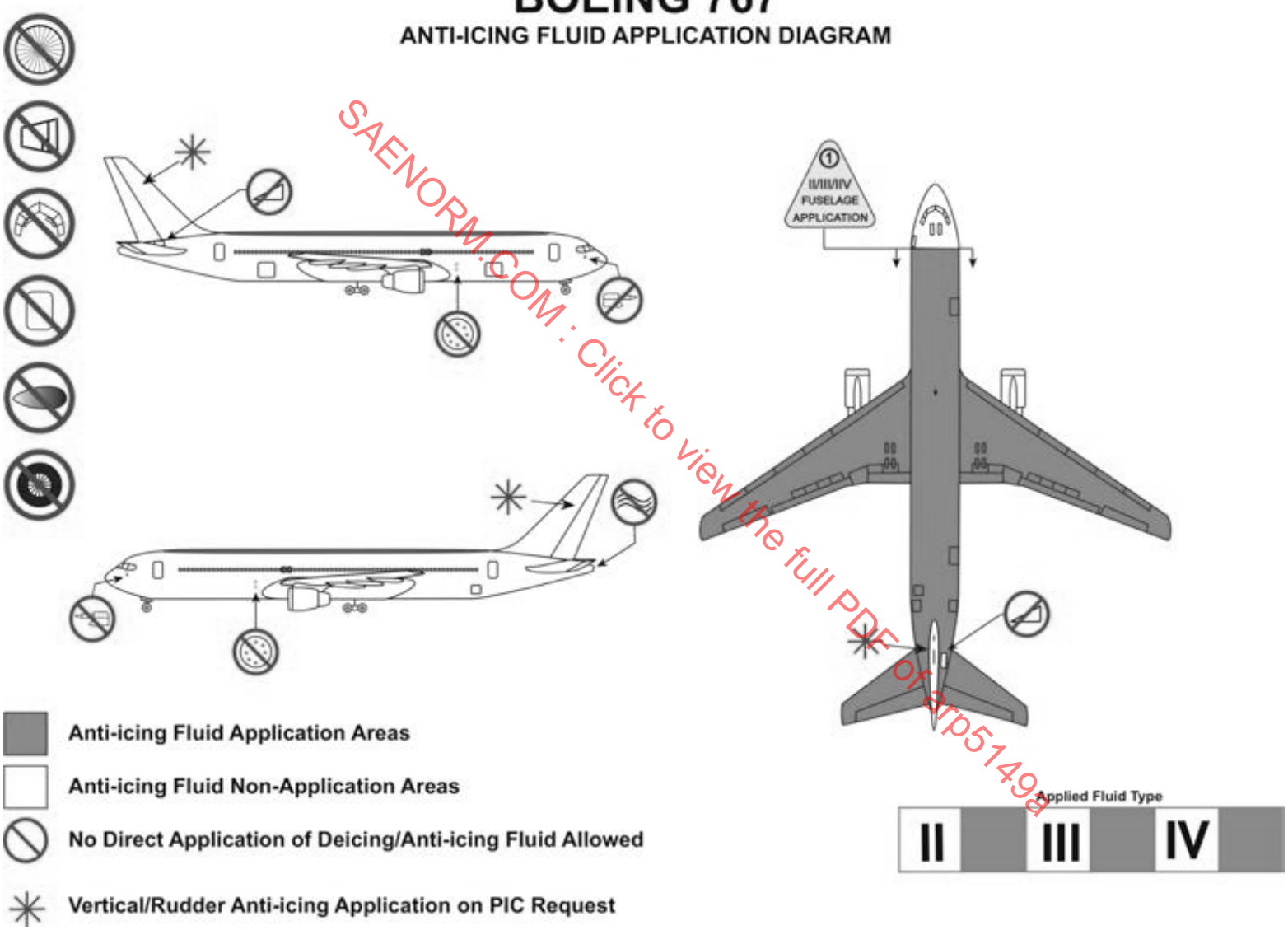
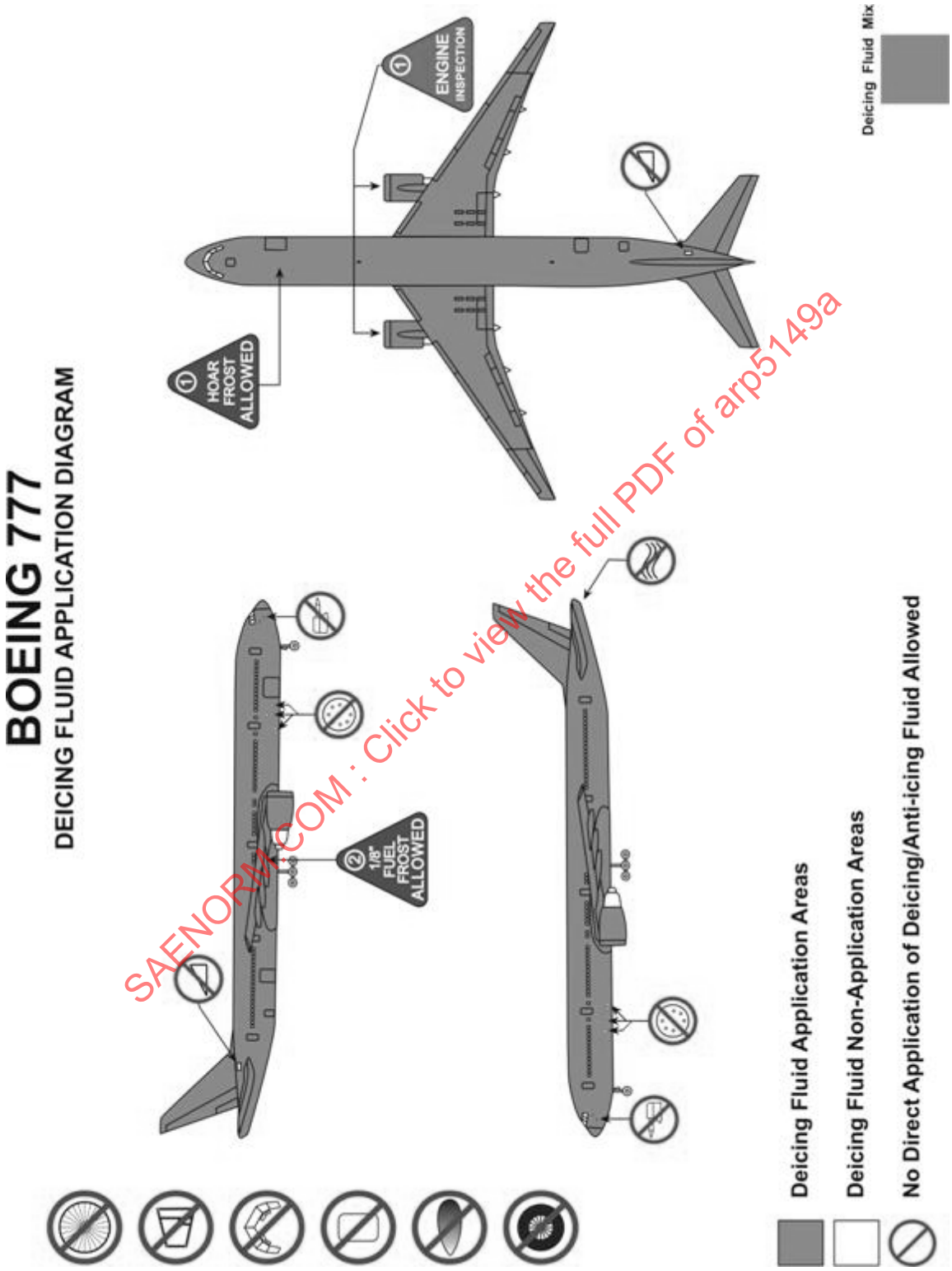
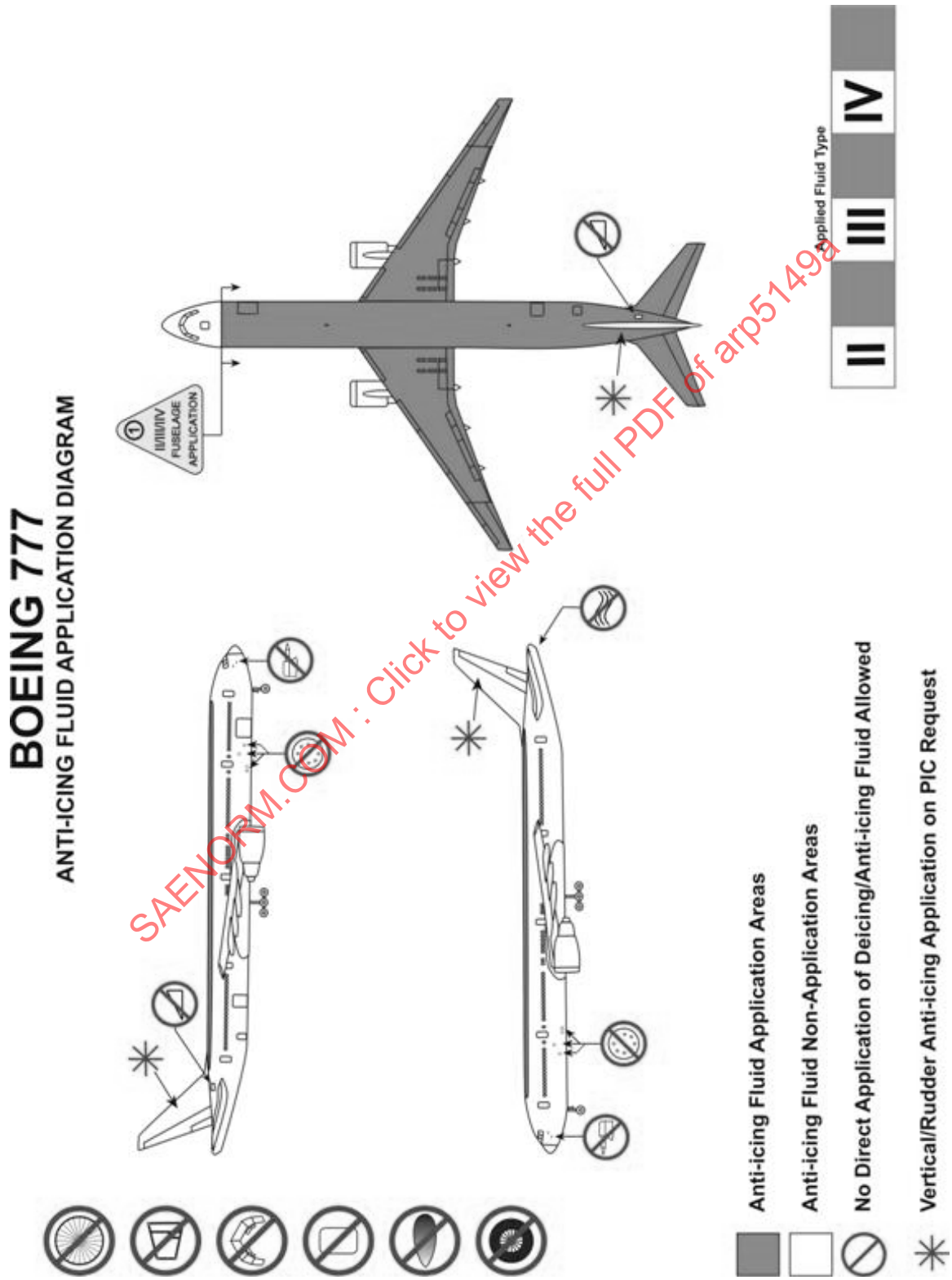
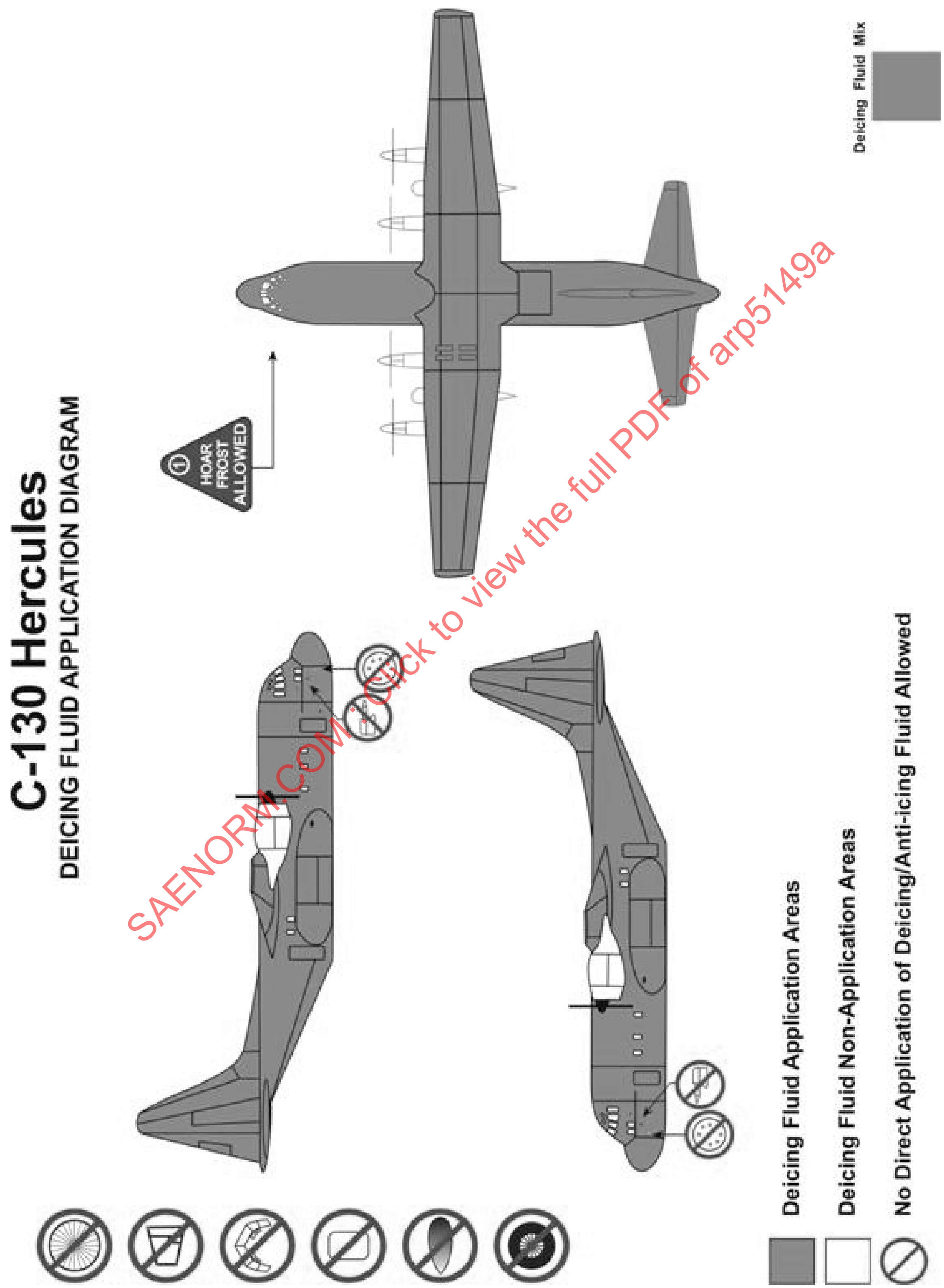


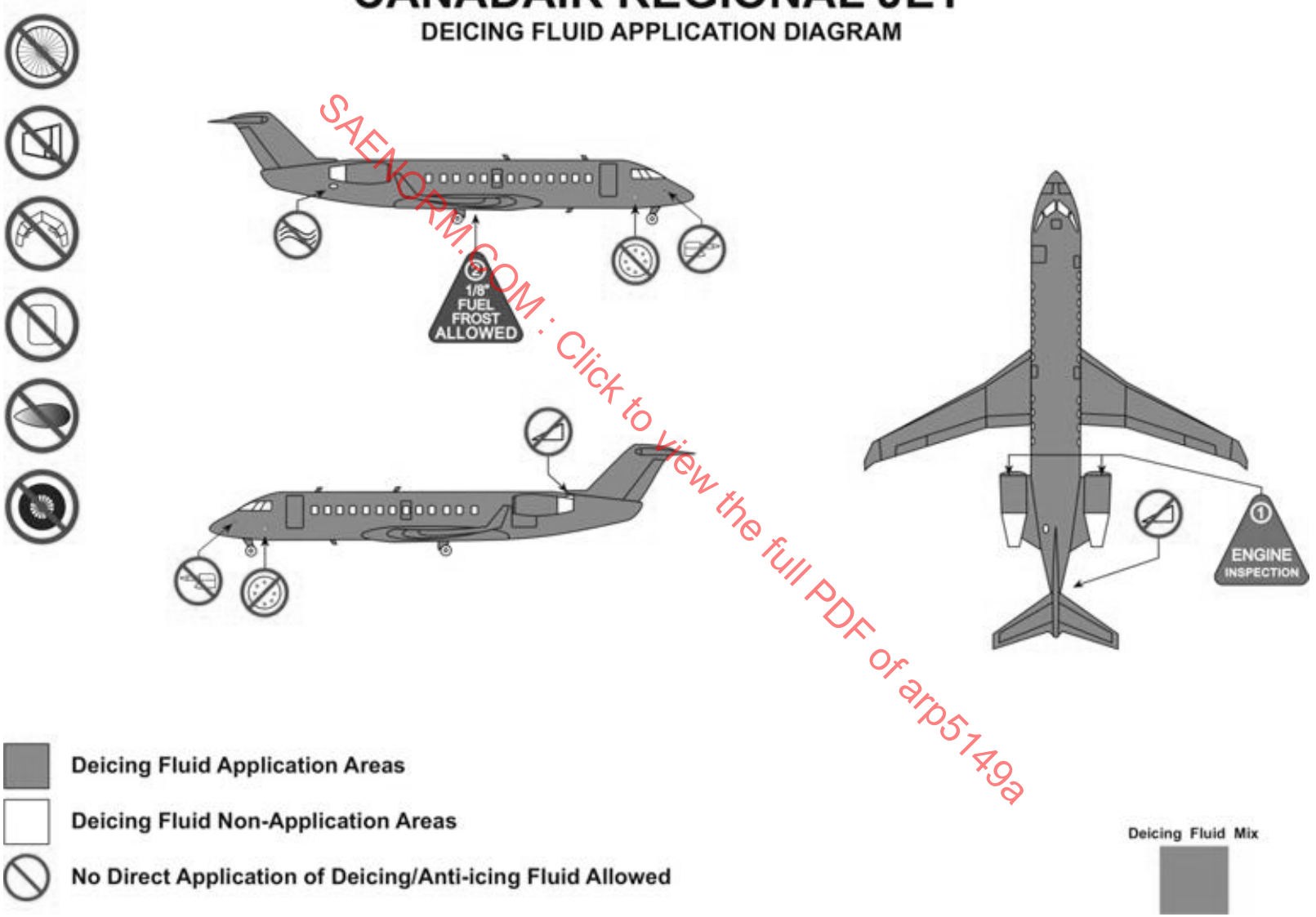






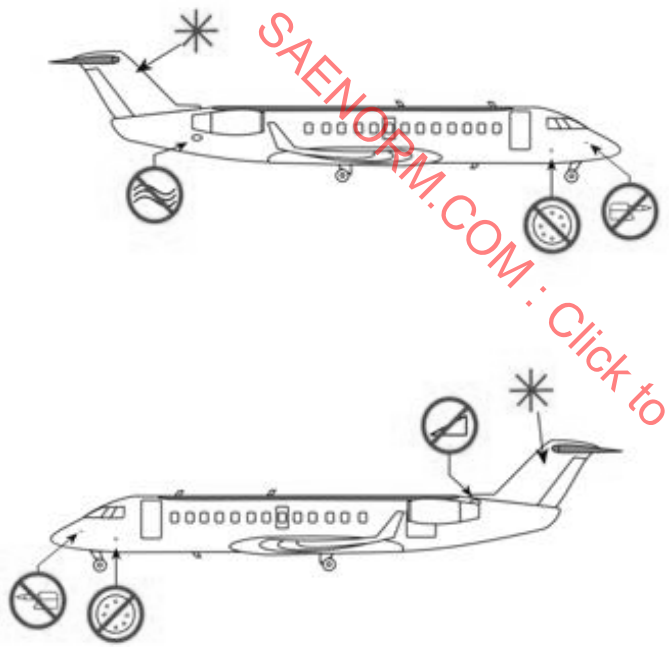
CANADAIR REGIONAL JET

DEICING FLUID APPLICATION DIAGRAM



CANADAIR REGIONAL JET

ANTI-ICING FLUID APPLICATION DIAGRAM

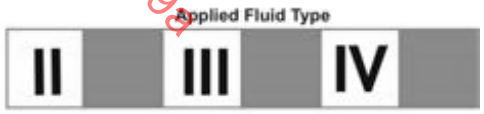


Anti-icing Fluid Application Areas

Anti-icing Fluid Non-Application Areas

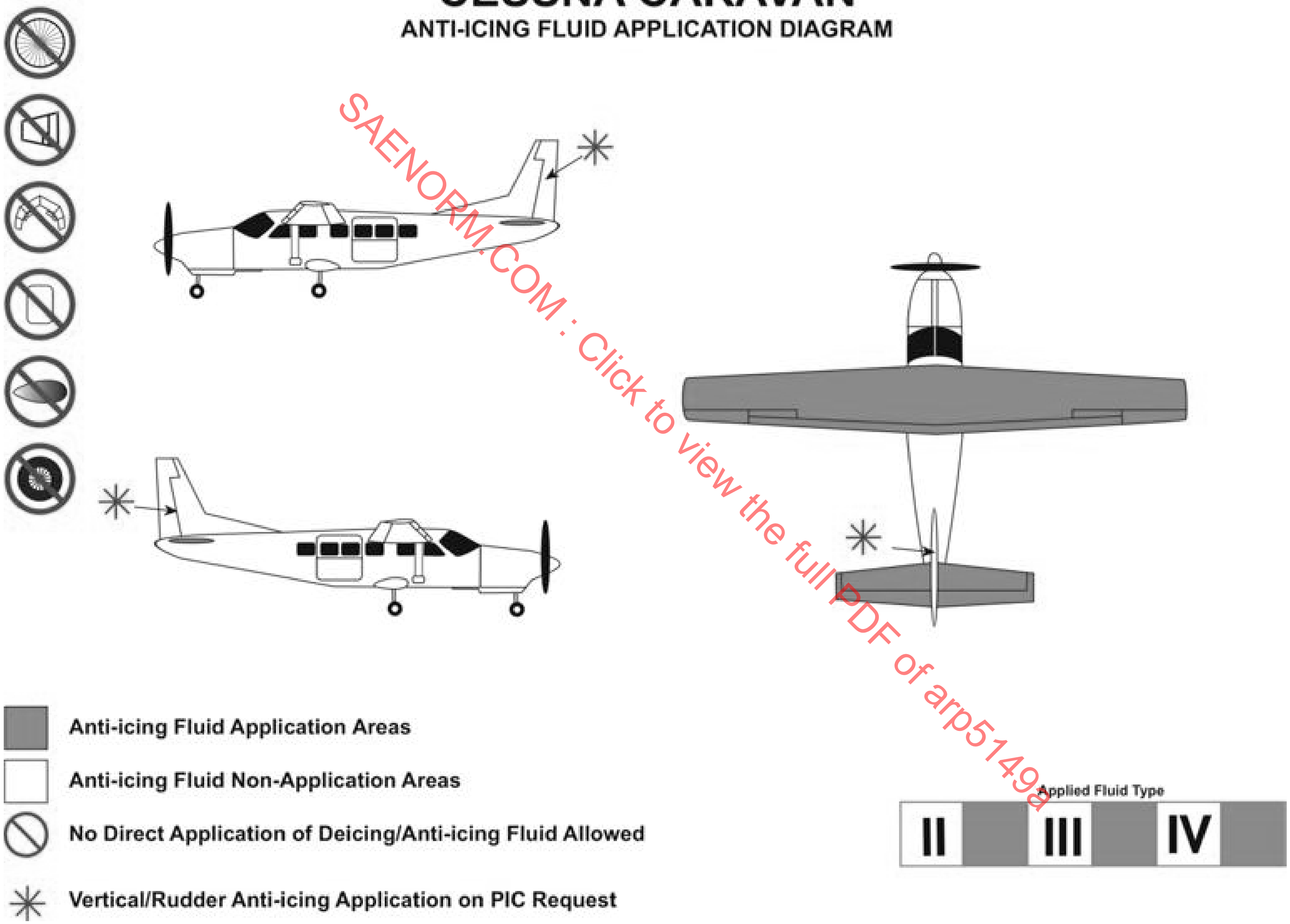
No Direct Application of Deicing/Anti-icing Fluid Allowed

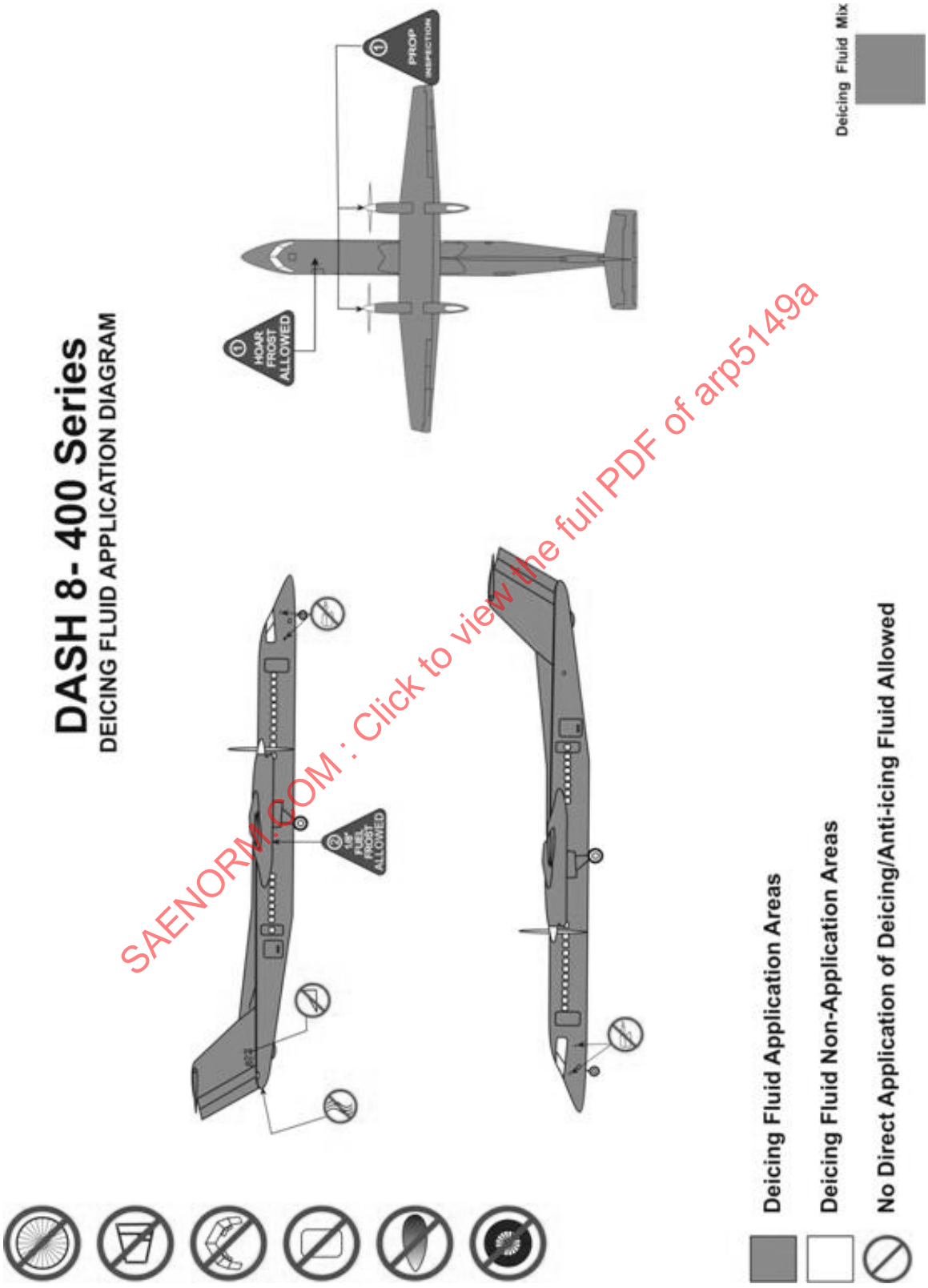
Vertical/Rudder Anti-icing Application on PIC Request



CESSNA CARAVAN

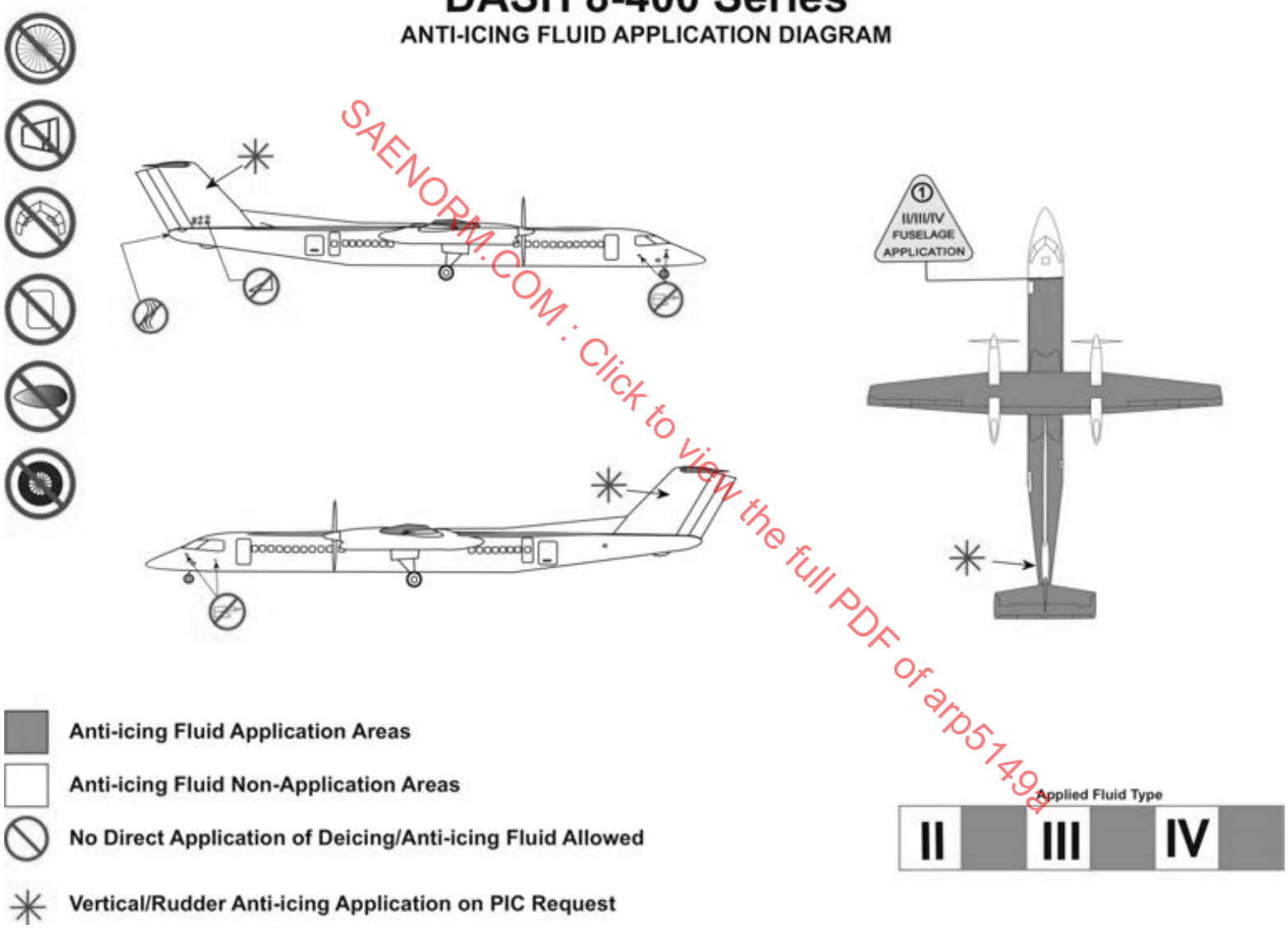
ANTI-ICING FLUID APPLICATION DIAGRAM





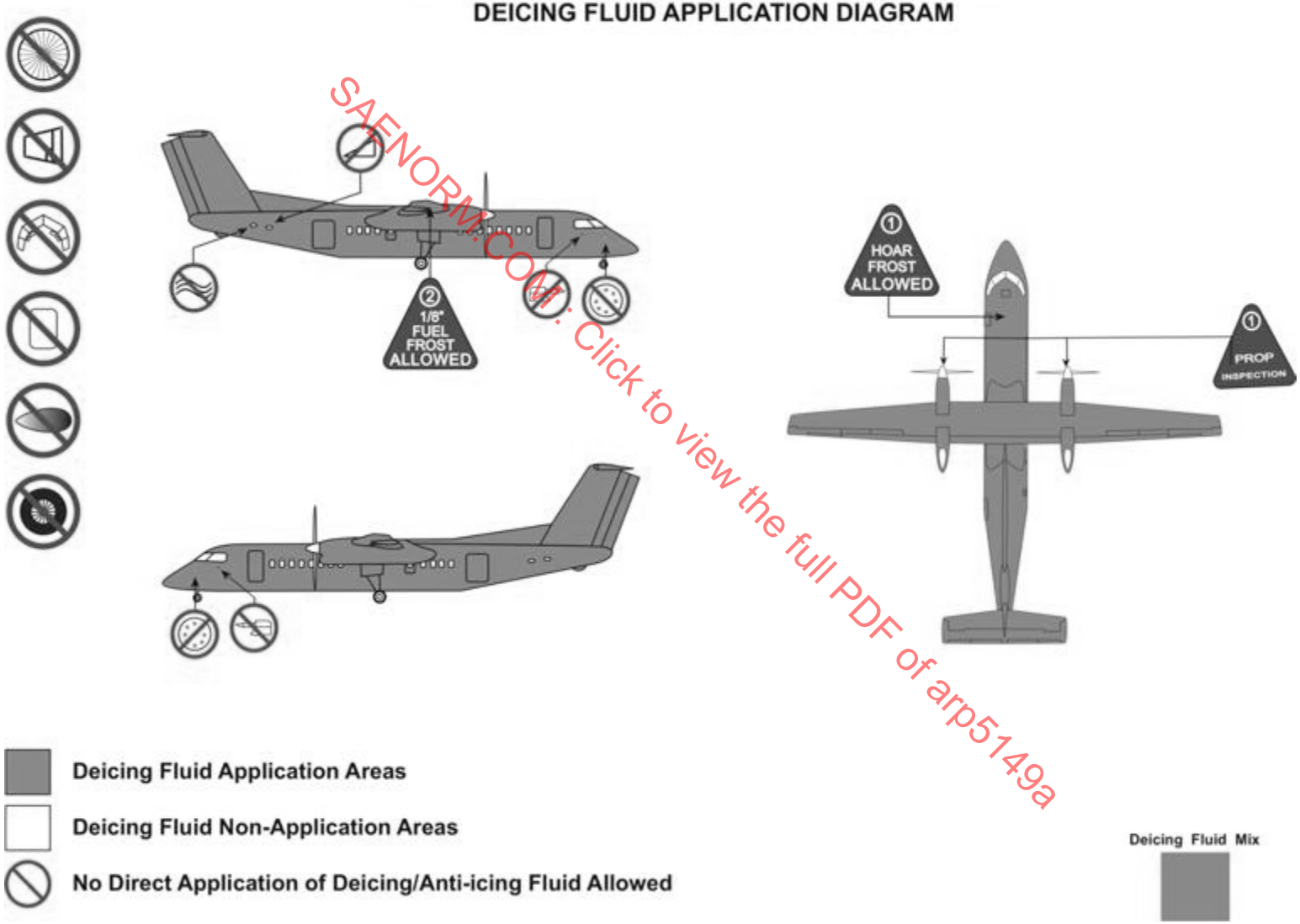
DASH 8-400 Series

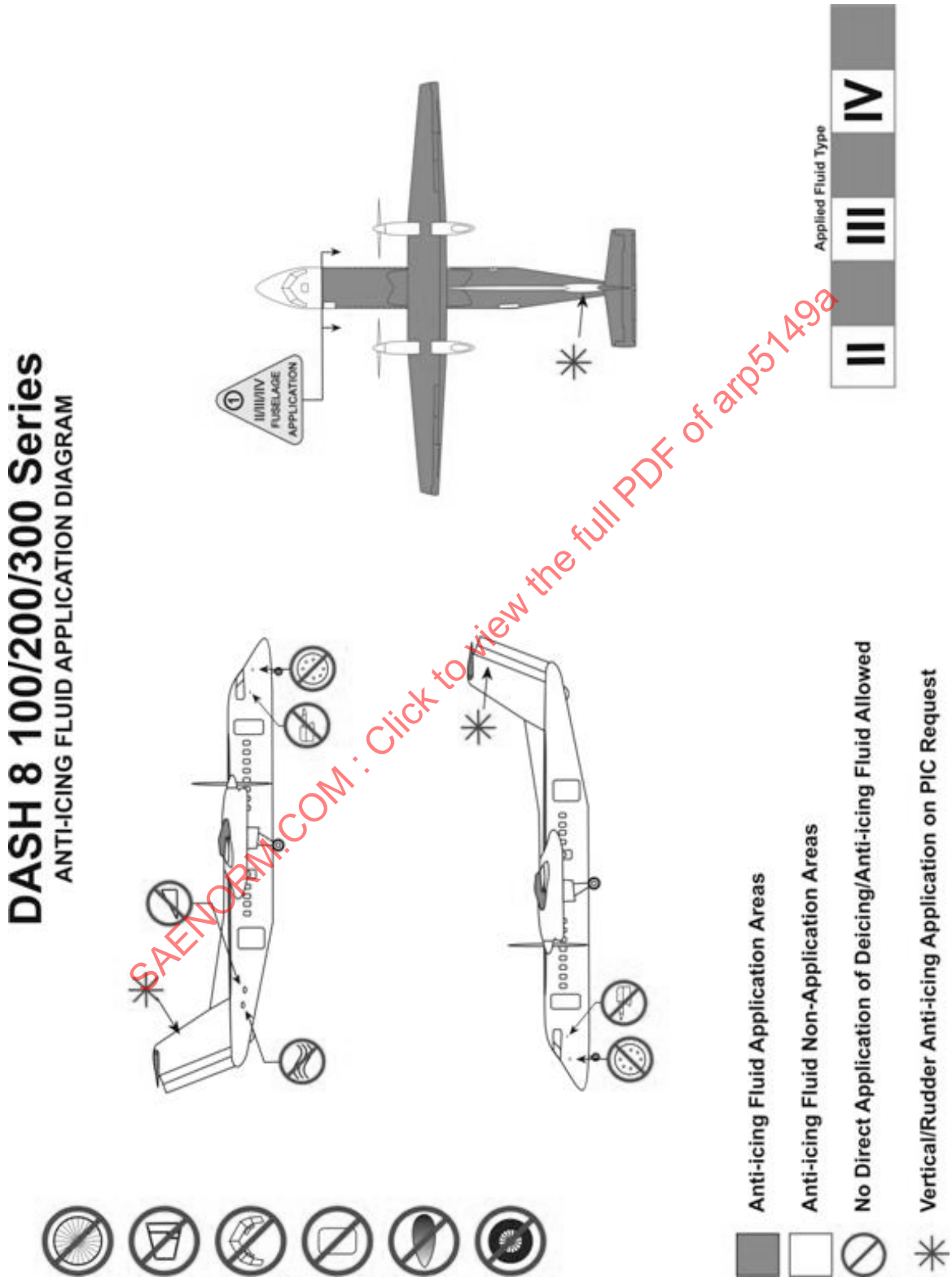
ANTI-ICING FLUID APPLICATION DIAGRAM

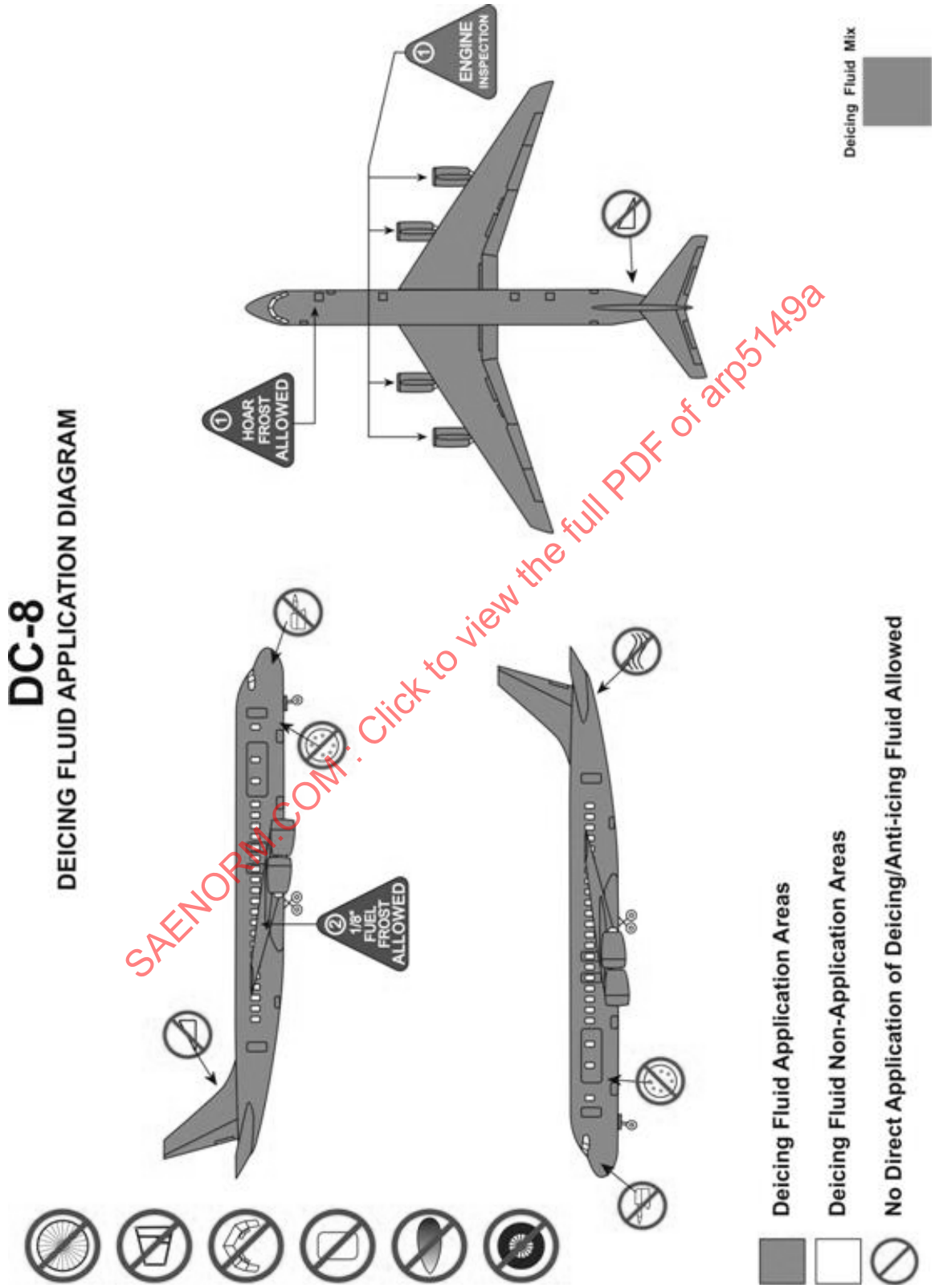


DASH 8 100/200/300 Series

DEICING FLUID APPLICATION DIAGRAM

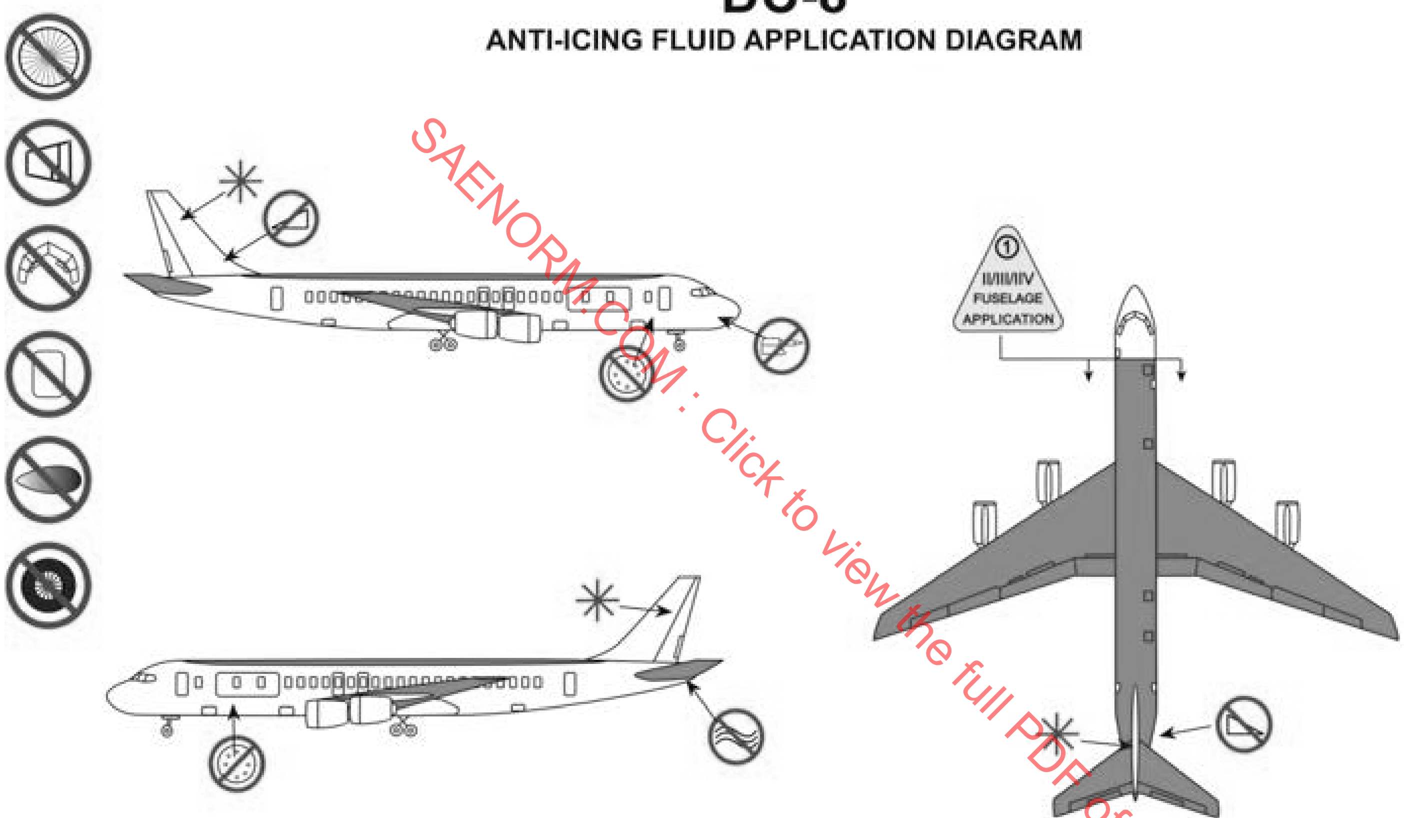




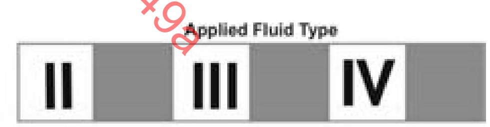


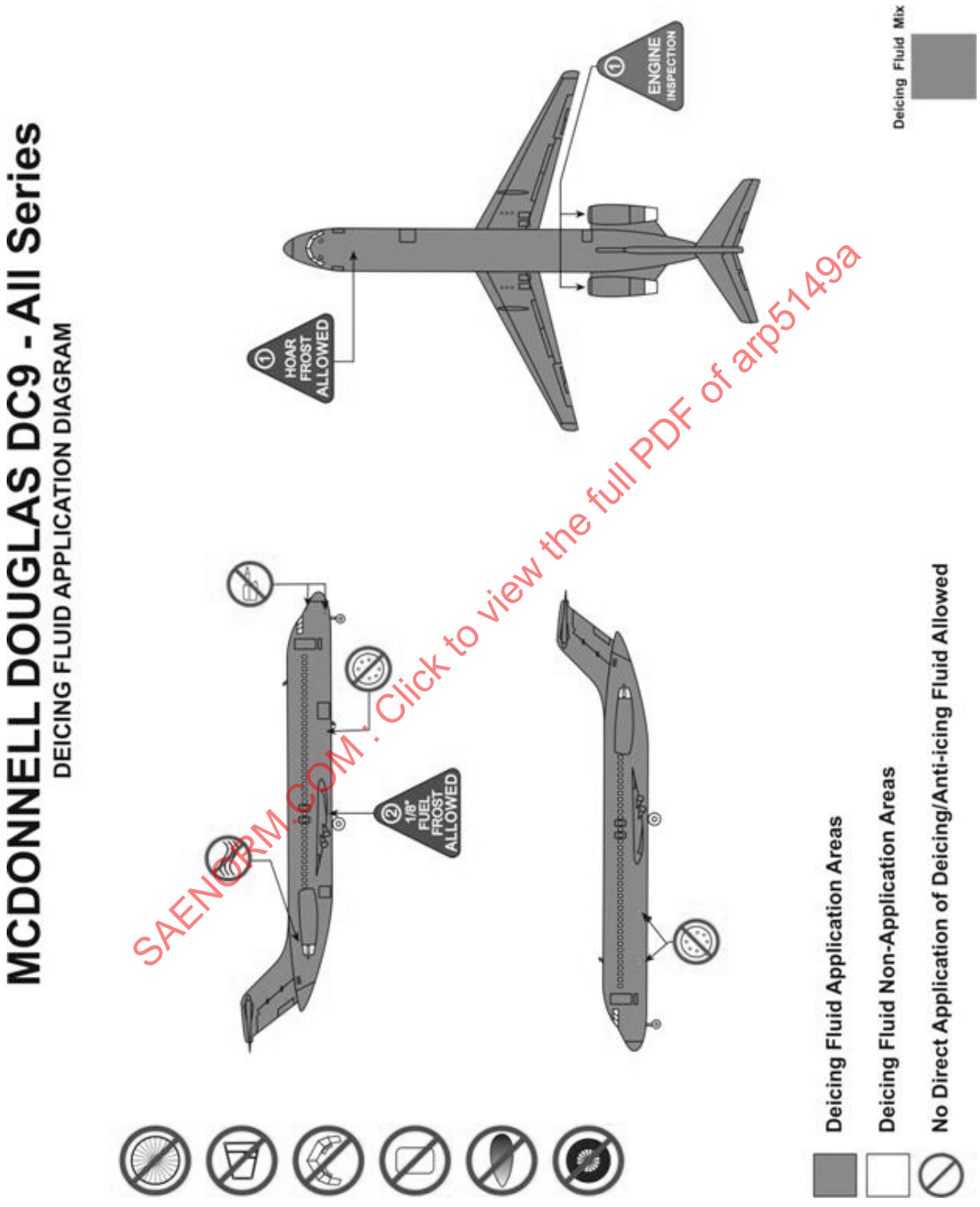
DC-8

ANTI-ICING FLUID APPLICATION DIAGRAM



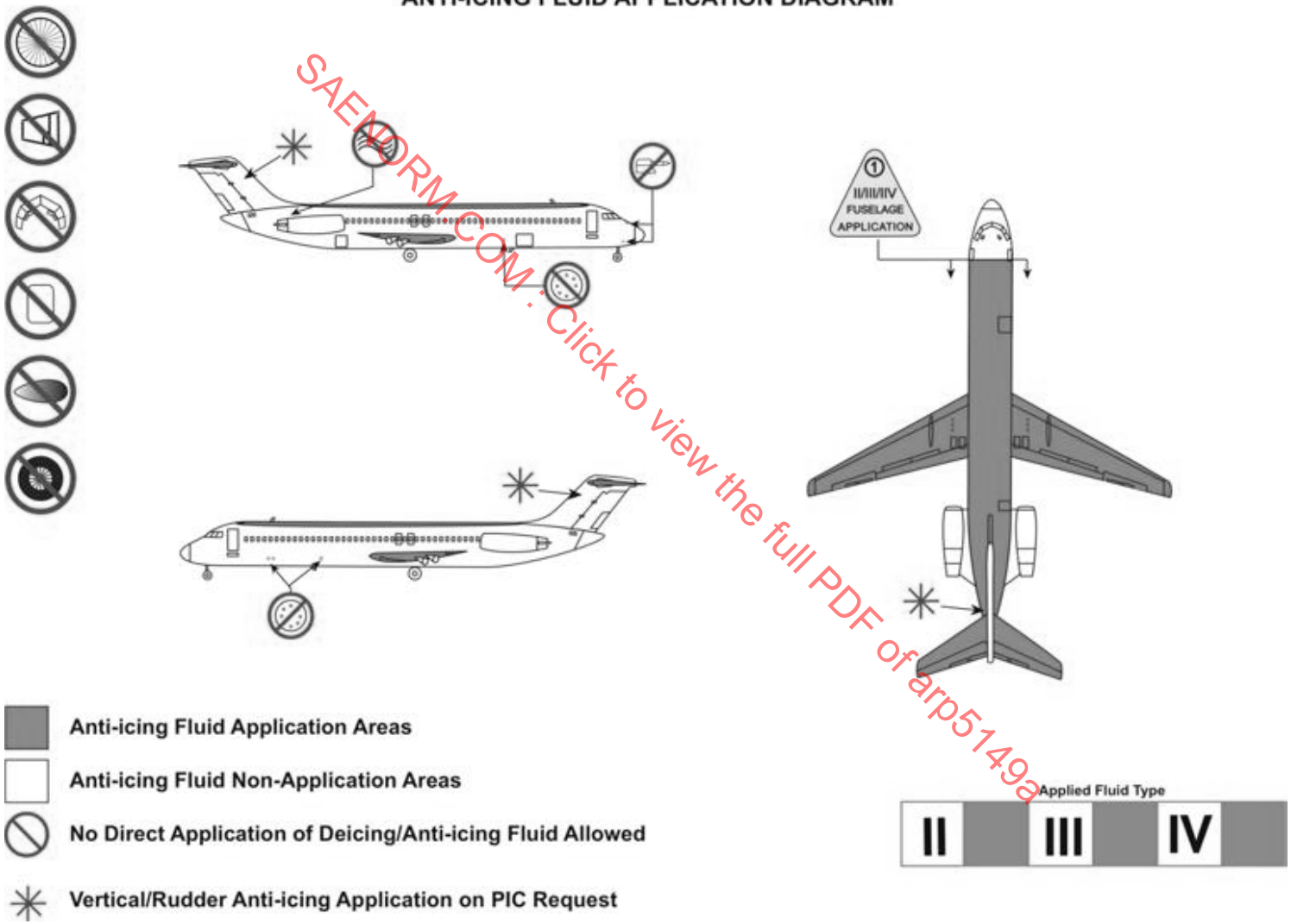
- Anti-icing Fluid Application Areas
- Anti-icing Fluid Non-Application Areas
- No Direct Application of Deicing/Anti-icing Fluid Allowed
- Vertical/Rudder Anti-icing Application on PIC Request

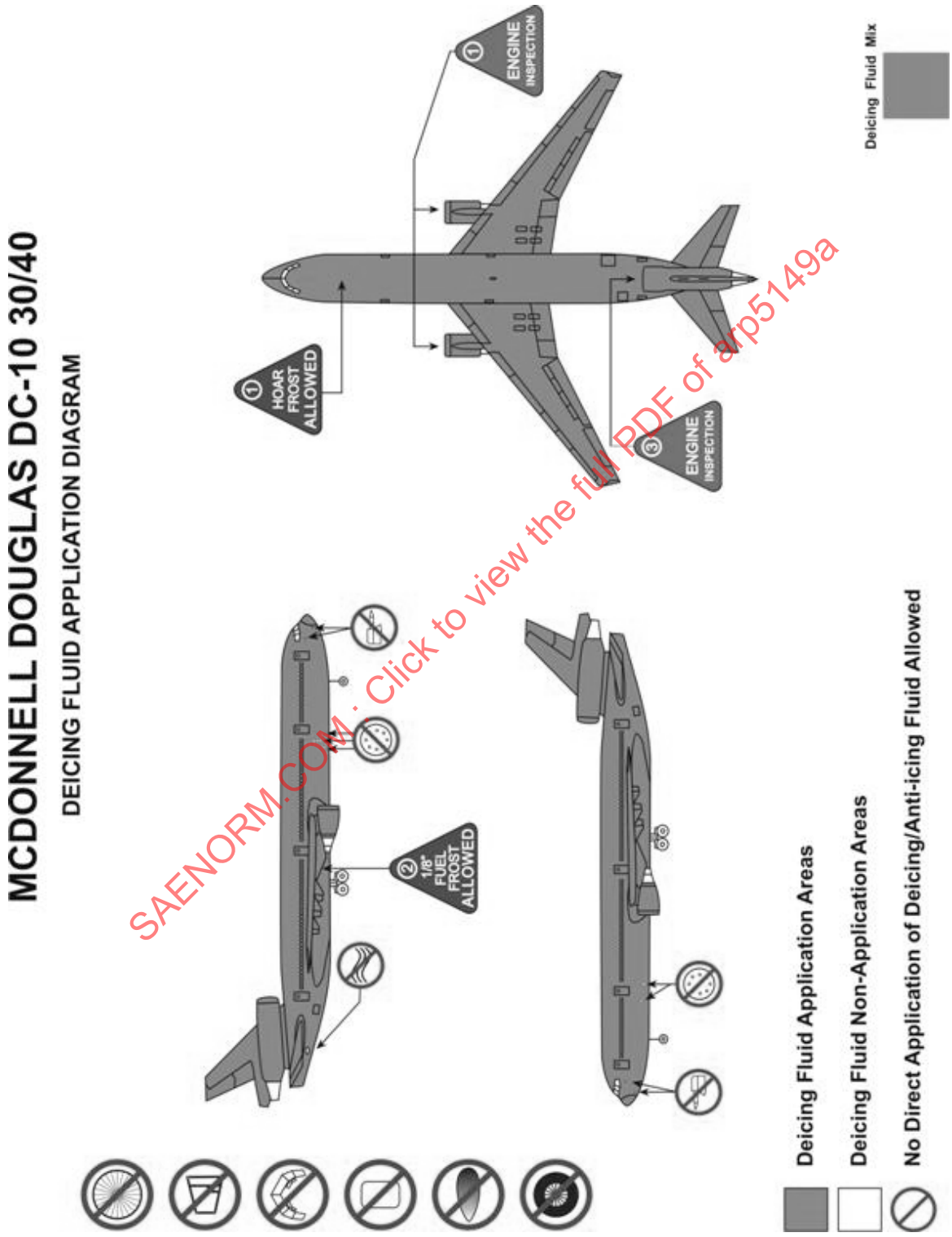




MCDONNELL DOUGLAS DC9 - All Series

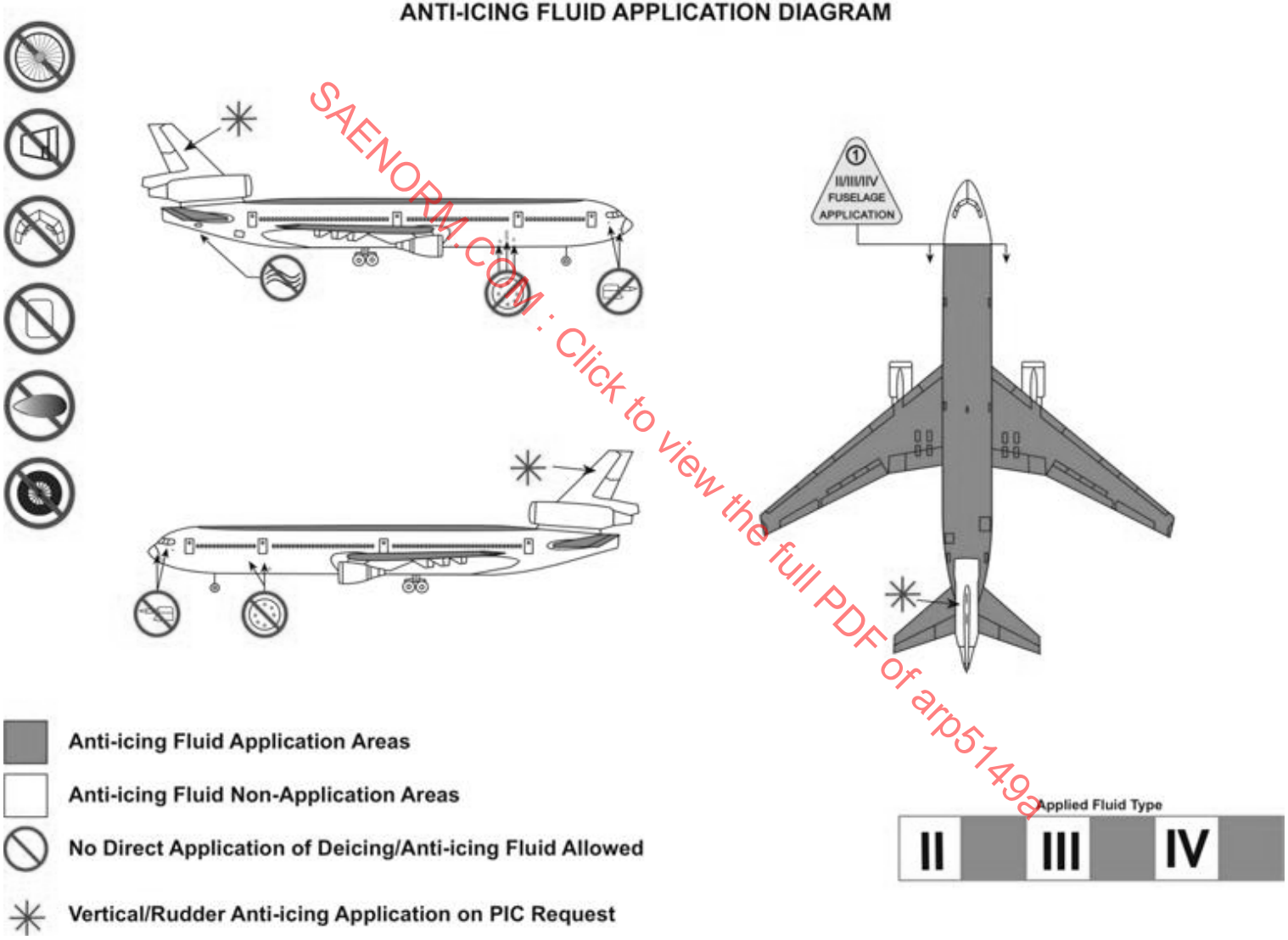
ANTI-ICING FLUID APPLICATION DIAGRAM

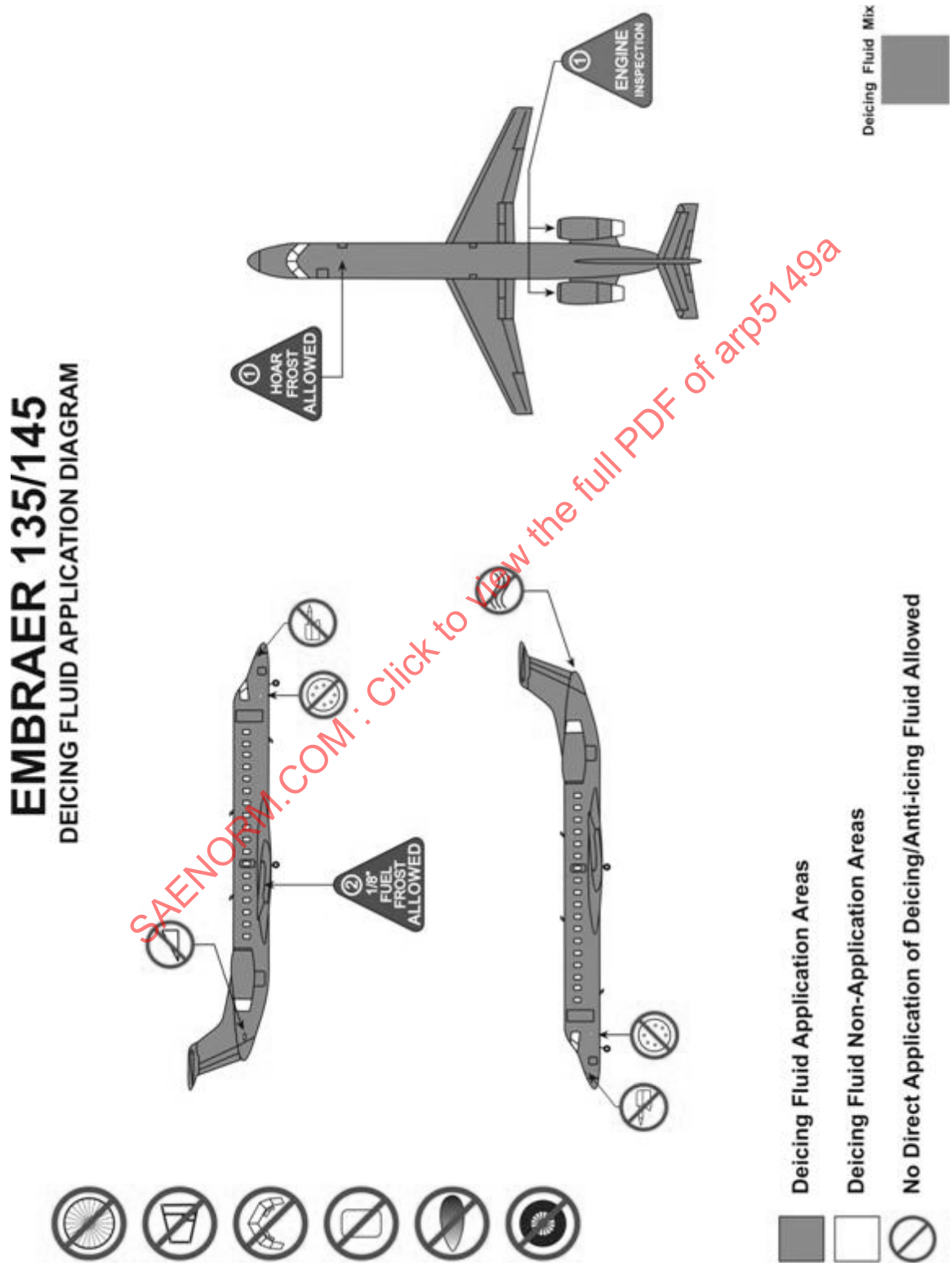


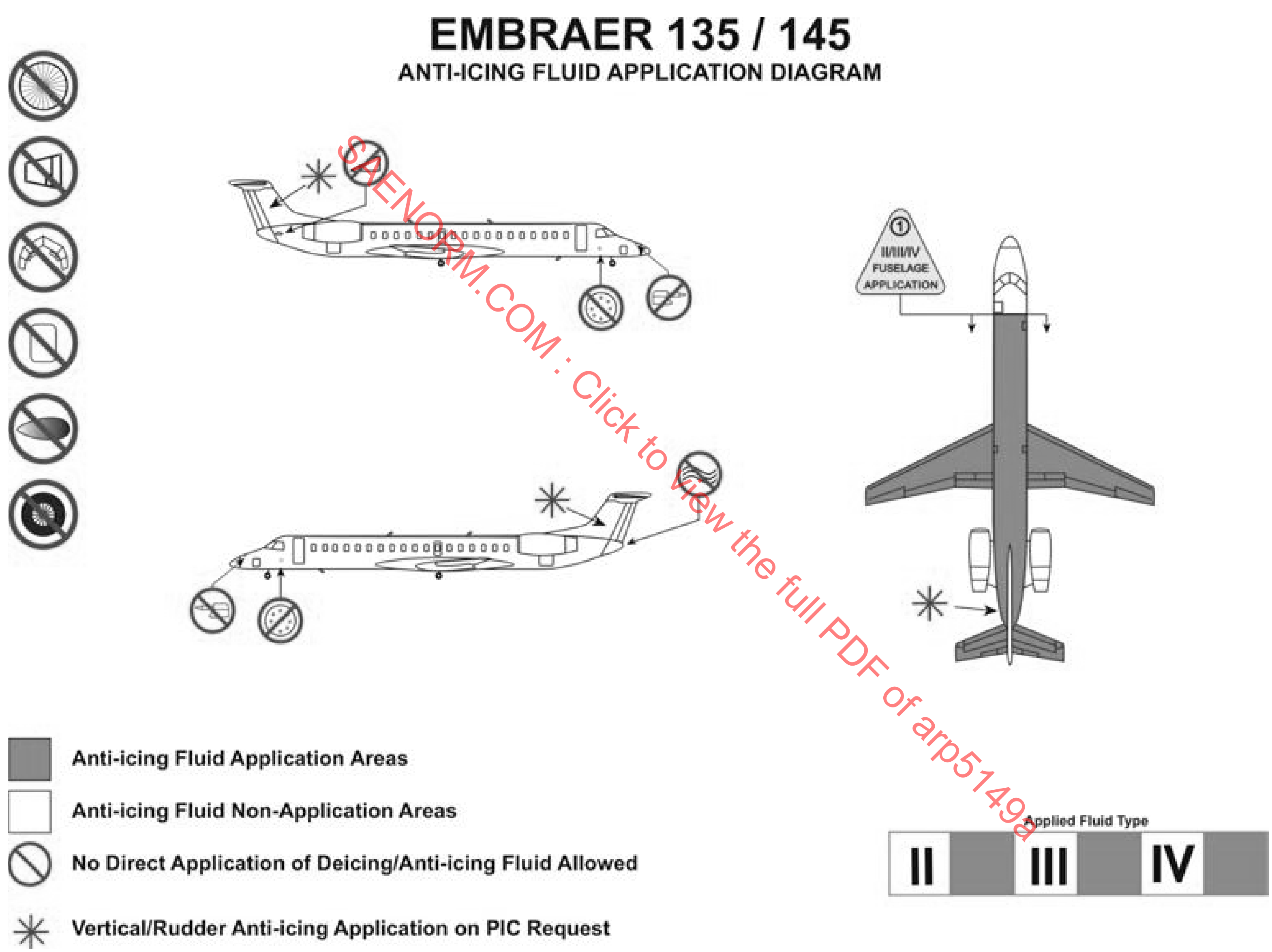


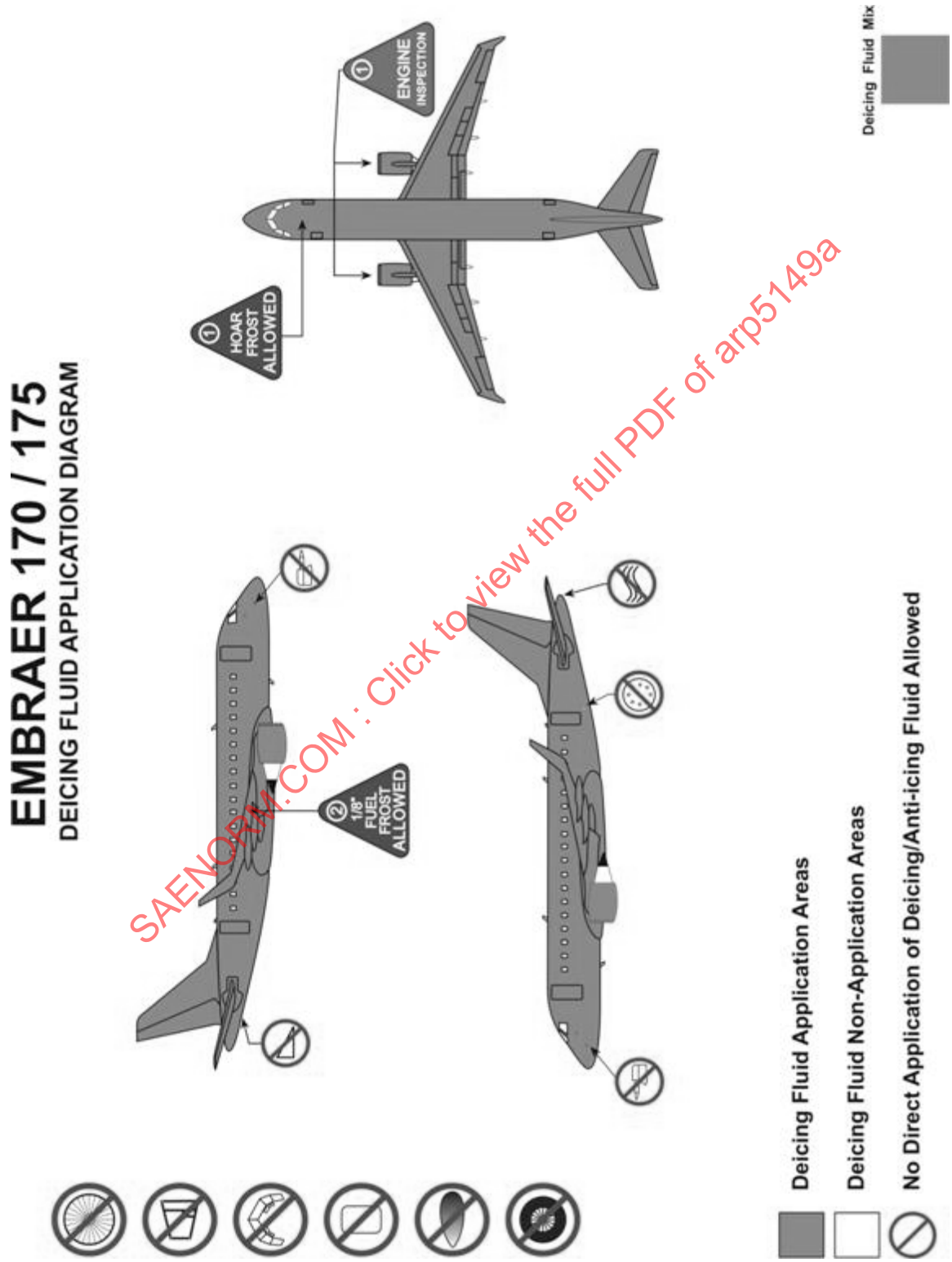
MCDONNELL DOUGLAS DC-10 30/40

ANTI-ICING FLUID APPLICATION DIAGRAM



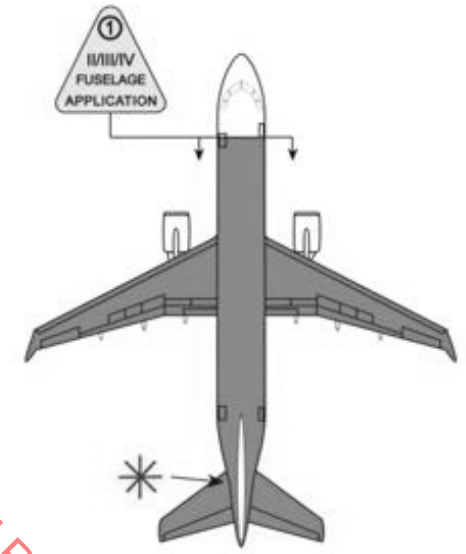






EMBRAER 170 / 175

ANTI-ICING FLUID APPLICATION DIAGRAM

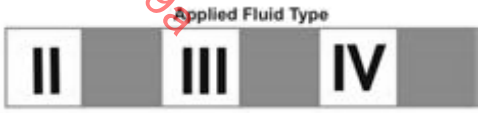


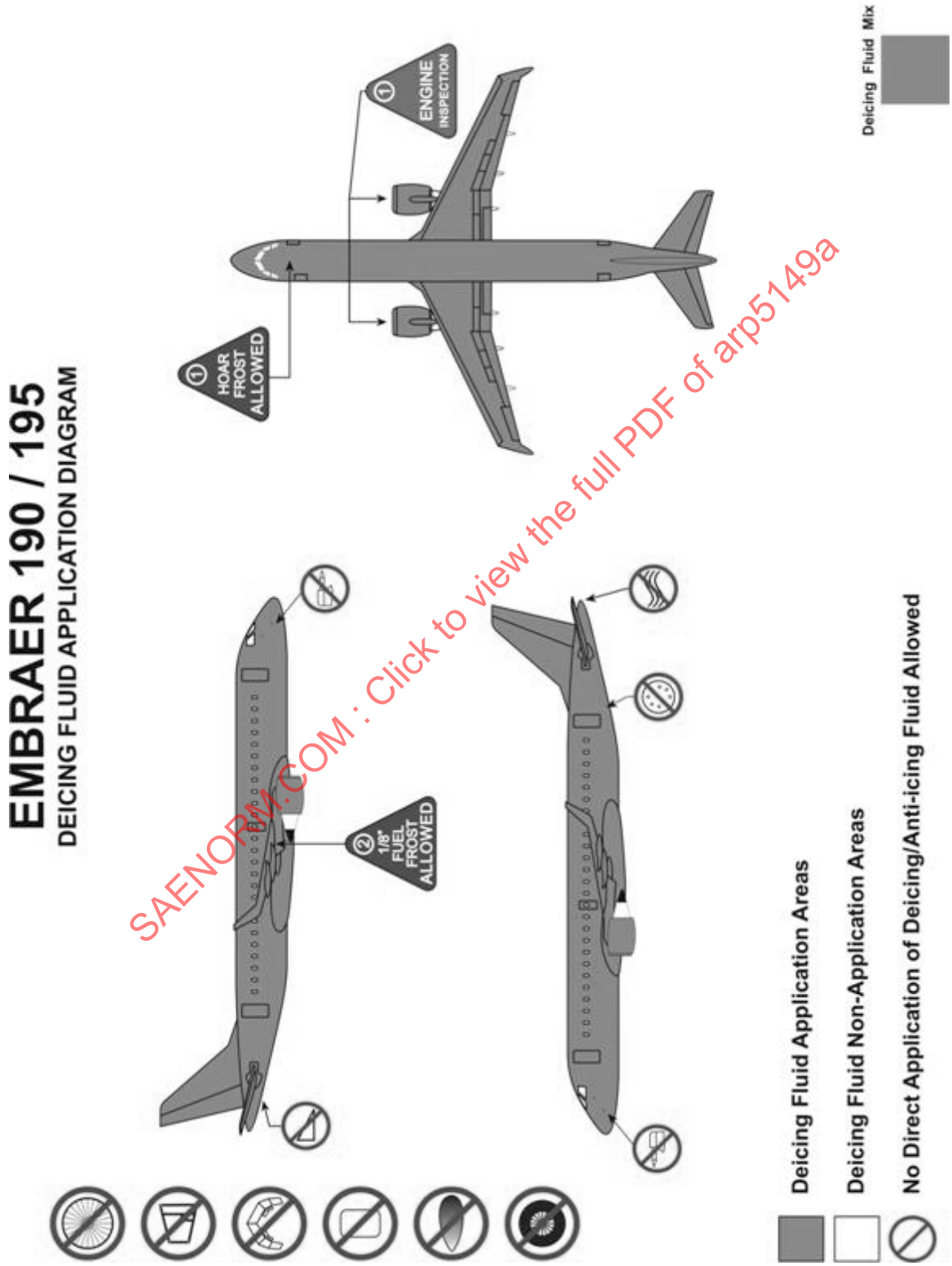
Anti-icing Fluid Application Areas

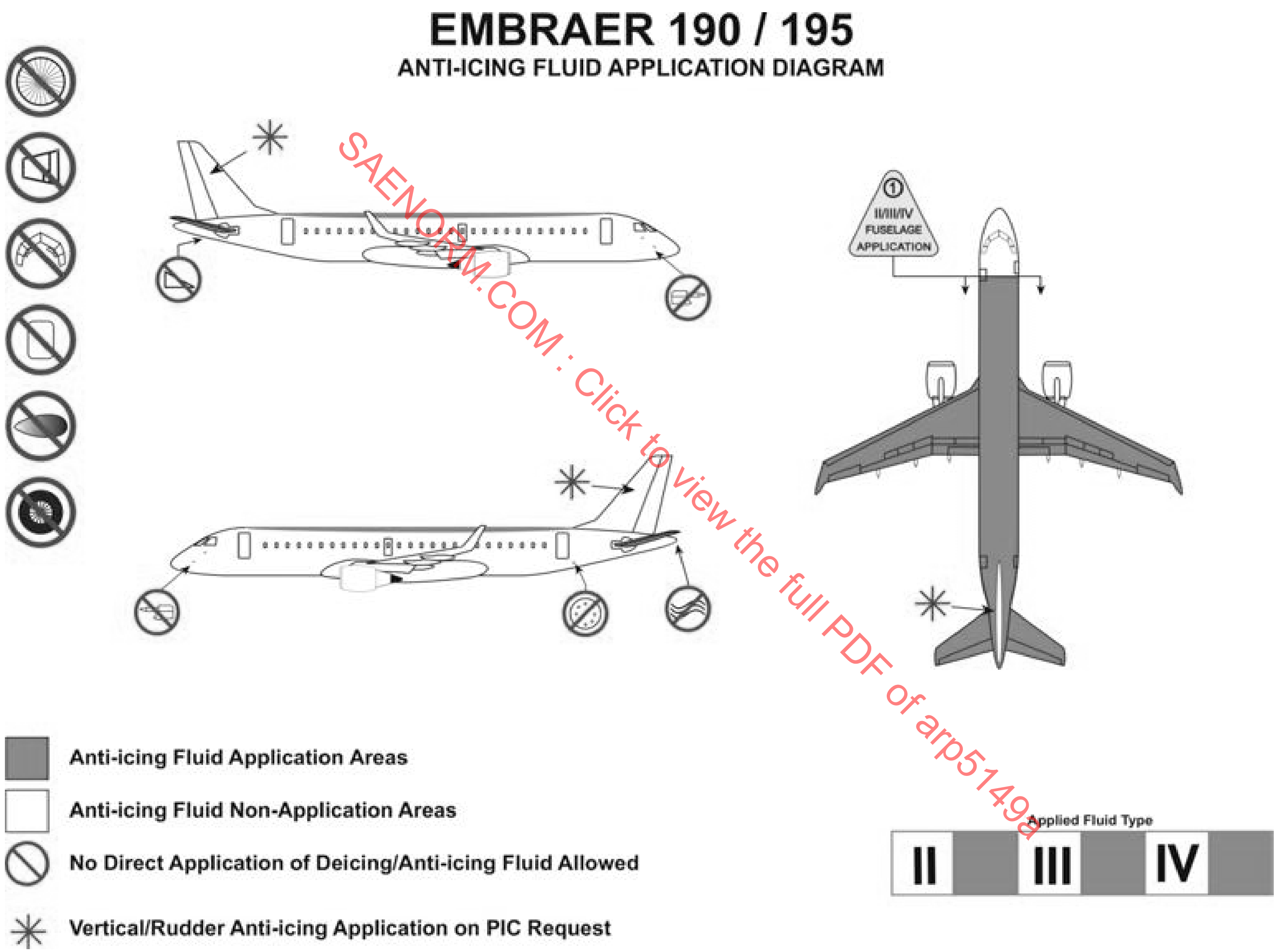
Anti-icing Fluid Non-Application Areas

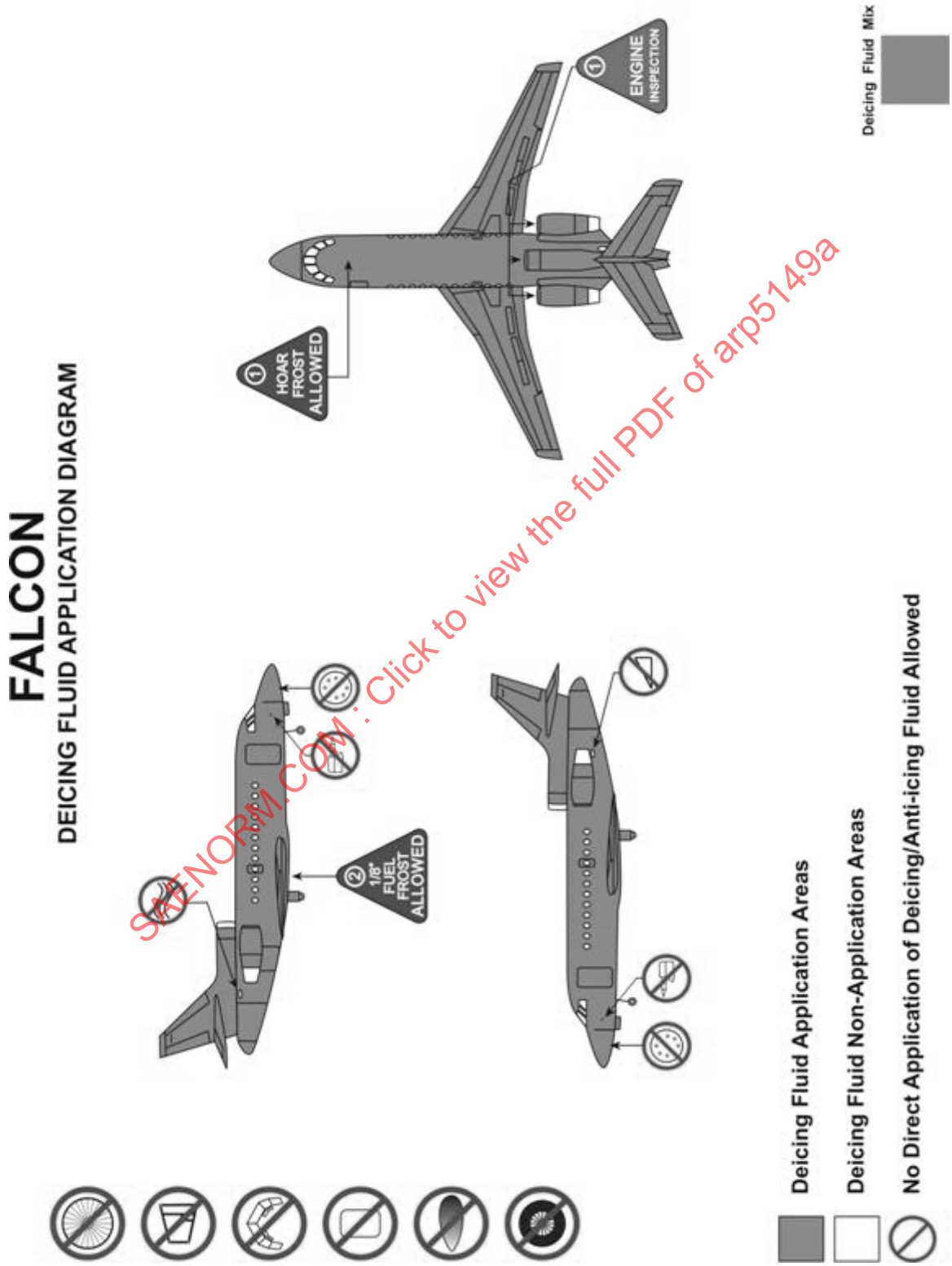
No Direct Application of Deicing/Anti-icing Fluid Allowed

Vertical/Rudder Anti-icing Application on PIC Request









FALCON

ANTI-ICING FLUID APPLICATION DIAGRAM